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AN ANALYSIS OF THE IMPACT OF RELIABILITY
AND MAINTAINABILITY ON MAINTENANCE
MANPOWER REQUIREMENTS AND MISSION
EFFECTIVENESS FOR THE F-16 IMPLEMENTATION
BY THE TURKISH AIR FORCE

THESIS

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First Lieutenant, TUAF

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A PROTOTYPE KNOWLEDGE-BASED SYSTEM TO AID SPACE SYSTEM RESTORATION MANAGEMENT

THESIS

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THESIS

Presented to the Faculty of the School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfillment Of the

Requirements for the degree of

Master of Science in Operation Research

Muammer Akpinar, B.S.

First Lieutenant, TUAF

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Preface

The purpose of this research was to provide a model which the Turkish Air Force (TUAF) decision makers can use in allocating maintenance manpower resources and to determine the impact of the improved reliability and maintainability on number of mission capable aircraft and sortie generation capabilities.

A simulation model of the aircraft maintenance system for a generic fighter squadron was developed using SLAM. In addition to the achievment of research objectives, the model has the potential to use further studies. The model can be used to analyze pilot training requirements for the F-16 implementation by the TUAF with the modifications of sortie generation segment and supply needs with the modification of unscheduled and phase maintenance segments.

I wish to thank my thesis advisor, Major Joseph R. Litko, for his assistance and advice throughout this study. I also want to thank Mr. Elliot Wunsh of ASD/ENSSC and Lt. Joe R. Felick, cheif, Maintenance Data Analyze Division at Hill AFB UT, for assisting me in obtaining the necessary data for this research. In addition, I would like to thank Col. Mete Seyithanoglu, the TUAF technical representive for F-16 at Hill AFB UT, for providing a TDY to examine aircraft maintenance system in person and his help and information concerning aircraft maintenance system.

Muammer Akpinar

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Abstract

The Turkish Air Force (TUAF) has decided to change its current centralized aircraft maintenance system to the combat oriented maintenance system for the F-16 implementation. An aircraft maintenance system is a highly complex system of resources and activities that interact to maintain a pool of mission capable aircraft. Because of its contribution to operational readiness and sustainability, managing manpower resources becomes even more critical as the new program is implemented and a new weapon system becomes operational.

Enhanced supportability depends upon efficent and effective resource allocation. In addtion to the many other topics concerning resource allocation and invesment trade off, improved reliability and maintainability (R&M) of modern weapon systems have become the focus of the top level decision makers. To assist in the R&M, a simulation model of the aircraft maintenance system for a generic fighter squadron was developed using Simulation Language for Alternative Modeling (SLAM). This research specifically addressed the impact of reliability and maintainability on maintenance manpower requirements and mission effectiveness. An additional question examined is the

impact of the consolidation of maintenance specialties on maintenance manpower requirements. A full factorial analysis of variance was used to address the impact of R&M on mission effectiveness. A non-statistical analysis was performed to address the impact of R&M on maintenance manpower requirements.

Due to the manner in which this model has been constructed, it is a flexible model that can be easily adapted to different aircraft.

AN ANALYSIS OF THE IMPACT OF RELIABILITY AND MAINTAINABILITY ON MAINTENANCE MANPOWER REQUIREMENTS AND MISSION EFFECTIVENESS FOR THE F-16 IMPLEMENTATION BY THE TURKISH AIR FORCE

I. Introduction

Background

Turkey has decided to strengthen its air power and to modernize its air force to fulfill its duties in the achievement of national objectives and North Atlantic Treaty Organization (NATO) requirements. Pursuant to this objective first, the Remobilization and Reorganization II (REMO II) program was adopted by the Turkish Air Force (TUAF) in 1984 to improve the maintenance and supply capabilities at both base and depot levels (1:15). Then, many studies have been done to determine the type and the number of aircraft required for modernization needs. The studies concluded that the F-16 would be the most suitable combat aircraft for the TUAF. Therefore, the F-16 will be a critical component of the TUAF modernization program and will take the most important role in the TUAF.

The Peace Onyx Program (2) for the procurement of the F-16 started in 1984 with the signature of a Letter of

Acceptance (LOA) between Turkey and the United States. Under this agreement, the first F-16 will be delivered in December 1987, and Turkey will continue to coproduction of the F-16. The Program Management Plan (PMP) covers all aspects of the Peace Onyx Program from signature of LOA to operational readiness. The PMP is the basic instruction that ties all actions together to ensure an efficient process of sale and transition to Turkey. The actions include contractor support, personnel training, logistic support, initial support, base preparation and related areas.

The adoption of a military fighter aircraft into a country's air force inventory requires the accomplishment of many actions. Implementation can be divided into a procurement phase,an initial transition phase and a fully operational phase. The actions for procuring the F-16 are ongoing. From an operational aspect, the initial transition phase is most important and requires systematic and detailed analysis to improve mission effectiveness in the fully operational phase.

Problem Statement

In its modernization program, the TUAF has decided to change its current centralized aircraft maintenance system to the combat oriented maintenance system. An aircraft maintenance system is a highly complex system of resources and activities that interact to maintain a pool of mission capable aircraft. Because of its contribution to operational readiness and sustainability, managing manpower resources becomes even more critical as the new program is implemented and a new weapon system becomes operational.

Enhanced supportability depends upon efficient and effective resource allocation. In addition to the many other topics concerning resource allocation and investment trade off, improved reliability and maintainability (R&M) of modern weapon systems have become the focus of the top level TUAF decision makers because of the need to quantify and minimize manpower requirements while improving mission effectiveness. To assist in the R&M process, a model must be developed that focuses on R&M issues and provides accurate prediction of the impact of R&M on maintenance manpower requirements and mission effectiveness. The accurate prediction of R&M impact will provide information to the TUAF decision makers to increase the capability of the TUAF to fly and fight using limited resources.

Reliability and Maintainability Issue

Prior to addressing specific research objectives it is necessary to define the terms R&M as they used in this study. "Reliability is the probability of a system/equipment performing its purpose adequately for the period of time intended under the operating conditions encountered"(3:1). "Maintainability is a quality of the combined futures and characteristic of equipment design which permits or enhances the accomplishment of maintenance by personnel of average skill under natural and environmental condition under which it will operate"(3:113-114). Bartlow stated that, "R&M contributes to system performance. The probability of a system functioning as specified for the duration of a mission is directly related to component reliabilty. Fewer failures, accompanied by more accurate diagnosis and fault isolation and reduced resource requirements during repairs, would substantially improve system availability"(4:10). Kniss defines reliabilty as a discipline and suggests that more complex models for estimating availability and ultimately, perhaps, total effectiveness should use reliability as input (5:25). Hodgson concluded that better determination and specification of R&M requirements will provide more system availability and effectiveness (6:13).

Research Objective

The overall objective of this research is to provide a model which the TUAF decision makers can use to analyze different maintenance initiatives for allocating maintenance manpower resources and to determine the impact of improved R&M on maintenance manpower requirements, number of mission capable aircraft and sortie generation capabilities.

In order to fulfill this objective, several subobjectives were accomplished. These subobjectives are:

1. Collect data on failure rates and repair times for major subsystems of the F-16 aircraft.

2. Model the flying operations and maintenance system of the F-16 aircraft in one generic squadron.

3. Structure and analyze an experimental design to evaluate and identify the impacts of improved R&M on maintenance manpower requirements, number of mission capable aircraft and sortie generation capabilities.

Methodology

The general technique that will be used in this research is simulation. Simulation is chosen over an analytic technique because of the probabilistic nature of modelling aircraft flying operations. The overall reliability and maintainability of an aircraft is dependent on many random processes. These random processes often interact with each other which makes the problem of determining availability and sortie generation rate very difficult to solve analytically. Simplifying assumptions can be made to make the problem analytically tractable, however, these numerous assumptions may cast doubt on the validity of the results. A simulation, on the other hand, can model the interactions between random processes and provide valid results.

As just discussed, simulation is the general technique chosen to accomplish the research objective. The study approach to accomplish the overall research objective involves accomplishing the subobjectives that were mentioned earlier: collecting data, modeling the flight operations and maintenance system, and experimental design for factor analysis.

Collecting data is the first phase of the research. Data must be collected that estimates the break rates and repair times of major subsystems of the F-16 aircraft. Since the TUAF does not have any experience with the F-16 aircraft, USAF data will be used as an input for break rates and repair times. There may be differences between the USAF maintenance support ability and the TUAF ability, but it is expected that similar rates will apply to TUAF.

After completion of data collection, the next phase is to model the flight operations and aircraft maintenance system. An important step in this phase is the verification and validation of the model as it is built. This process will be described in detail in the next chapter.

Once the final model has been verified and validated, the last phase of the research is to estimate the effect of R&M on the dependent variables by using an appropriate experimental design. Factorial analysis, analysis of variance and regression analysis techniques will be used to discover which independent variables have a significant effect on performance measures.

Scope

Two scenarios will be used for analyses in this study. A peace time scenario will be used to address the manpower questions and a thirty day wartime surge scenario will be used in assessing mission capability impacts. Each of these scenarios will be described in the next chapter.

The purpose of this research is to evaluate the impact of improved R&M on maintenance manpower requirements, number of mission capable aircraft, and sortie generation capabilities. The study will not address the total manpower requirements and maintenance cost for a specific squadron.

The model will assume that spare parts are available when needed, and cannibalization will not be considered in this study. These factors will be taken into consideration as a non-mission capable supply (NMCS) percentage rate of the aircraft resources.

Overview

The remainder of this thesis contains four chapters. Chapter II gives a brief discussion of Combat Oriented Maintenance Organization, provides a description of the flight operations and aircraft maintenance system, and identifies measures of merit and scenarios which will be used in this research.

Chapter III describes the simulation model and identifies input variables. It also addresses the assumptions and limitations of the model and describes the methods of verification and validation used.

Chapter IV provides a description of the analyses performed and the results of each analysis.

The final chapter, chapter V, discusses conclusions and recommendations based on the model developed and analyses performed.

II. Operational Structure

Introduction

Operational readiness is the term used to indicate the ability of a system to be utilized upon demand. It consists of a number of factors, the primary ones being the inherent reliability of the system, its ability to be maintained, and its mission or operational demand requirements in its operational environment. The measure of operational readiness is the number of mission capable aircraft that is the outcome of the aircraft maintenance system. As a highly complex system of resources and activities, the principal concern of the aircraft maintenance system is to increase operational readiness, while performing operational maintenance requirements.

This chapter discusses the flight operations of one generic F-16 squadron, including the general structure to be translated into a model. Understanding of the system should precede the model construction, since a model is a description of a system. Information on the maintenance operations and the framework of the system was obtained from interviews with related personnel (7) at Hill AFB, UTAH and the personal experience of the author as an aircraft maintenance officer.

Combat Oriented Maintenance Organization

After taking the new fighter aircraft into its inventory, the TUAF can achieve maximum flown sortie and aircraft readiness goals by correctly applying logistics and management principles. In the fully operational phase, the availability of the F-16 can be improved by buying more spare parts or employing intensified maintenance procedures. However, this could lead to high support costs and budgetary shortfalls. To improve the availability of the F-16, the TUAF will change its current centralized maintenance system to the Combat Oriented Maintenance Organization (COMO).

COMO is based on a decentralized maintenance policy. The main differences between COMO and the centralized maintenance system are the maintenance squadron structure and functions. Maintenance staff sections do not differ too much. Under COMO, there are five maintenance staff divisions (Maintenance Superintendent, Quality Control, Maintenance Control, Training Management, and Management Control) and three maintenance squadrons (Aircraft Generation, Component Repair, and Equipment Maintenance Squadrons)(8:33). The structure of the COMO is shown in Figure 1. Maintenance Staff divisions function as supervisors and coordinators among all maintenance squarons under the decentralized maintenance policy. They apply the base maintenance policy and control the functions of the maintenance squadrons.

Under COMO, on-equipment technicians will be assigned to the flight line squadron called an aircraft maintenance unit (AMU) with cross training in the highly repetitive flight line

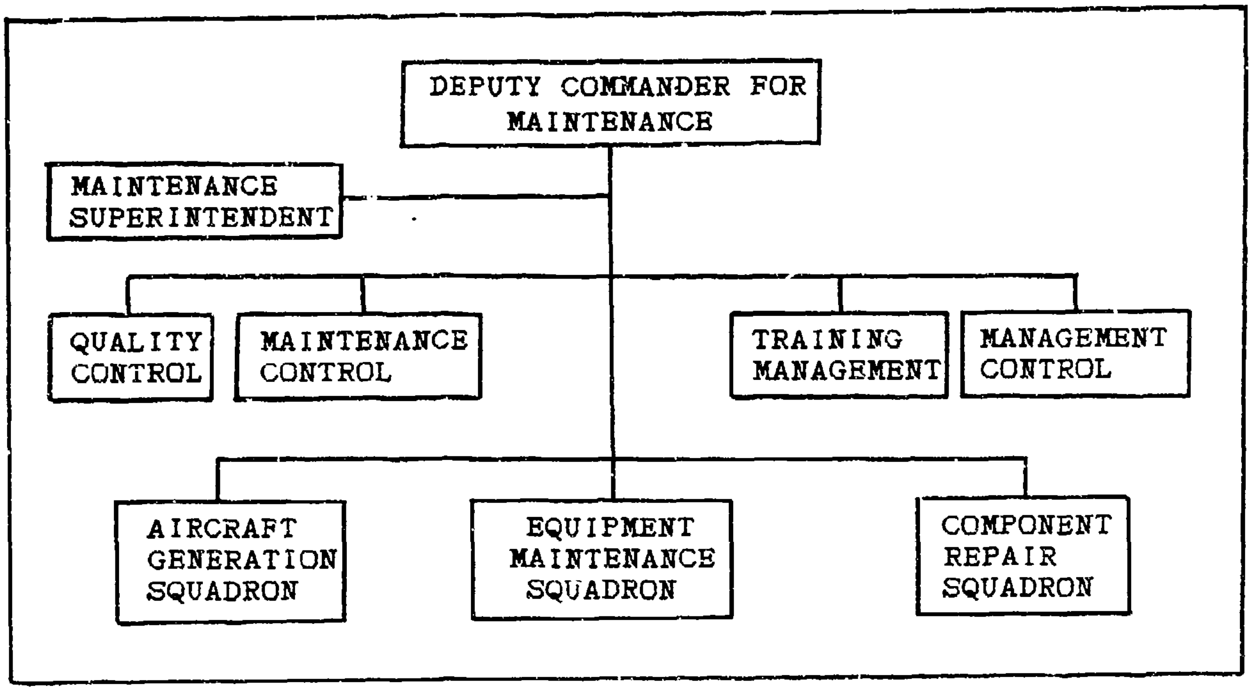

Figure 1. Combat Oriented Maintenance Organization Structure

tasks. With this new structure, the AMU will have more responsibility and authority over repair actions. This will expand total work flexibility, simplify specialist dispatch, and decentralize production decisions to improve sortie capabilities.

The assignment of specialists to the flight line squadrons will result in a major realignment of the previous centralized maintenance squadron functions and responsibilities. Foremost, it is a reduction of one maintenance squadron resulting in the following designations (9:13-14).

<u>Aircraft Generation Squadron (AGS).</u> AGS will take the old flight branch of crew chiefs and add the flight line

specialists from the Field Maintenance Squadron (FMS) and Avionics Maintenance Squadron (AMS) and the load crews and on-equipment weapons release and gun services specialists from the Munitions Maintenance Squadron (MMS). The total assigned personnel will be allocated among AMUs, the number is determined by the number of aircraft and tactical fighter squadrons. The AMUs will be aligned with the fighter squadrons by unit designation, patches, and flying schedules when possible. A large support branch will serve as the focal point for the consolidation of equipment, parts, and vehicle support.

<u>Component Repair Squadron (CRS)</u>. This squadron repairs avionics and aircraft system components, operates metal fabrication activities, and performs in-shop repairs of jet engines and aircrew training devices and PMEL functions.

<u>Equipment Maintenance Squadron (AMS)</u>. This squadron is responsible for Aerospace Ground Equipmet (AGE) and all munitions activities except those transfered to the AGS. Also it is responsible for aircraft inspection, fuel and egress systems, and transient aircraft.

As a graduate student at the Air Force Institute of Technology, Lt. Aydin Yilmaz conducted research (8) on COMO using the TSAR computer model. He analyzed the differences between these two maintenance organizations and compared the effectiveness of these two systems by using flown sortie rate, number of NMC aircraft, and NMC hours/hole as measures of effectiveness. "The study results indicate that while COMO produce 84 sorties a day, centralized maintenance system can produce 71 sorties a day. COMO provides 78 percent of scheduled sorties, for the period centralized maintenance provides only 66 percent" (8:50).

System definition

The flight operations of the fighter squadron can be described under two broad headings, flying activities and maintenance actions. There are two categories of maintenance actions, scheduled maintenance and unscheduled maintenance.

Scheduled maintenance is the preventive maintenance that is performed on a scheduled basis as specified milestones of operation are reached, such as total flying hours, total number of the sorties. The purpose is to keep an item or a system in a satisfactory operating condition (to keep the aircraft in a ready-to-fly status). The concept is to inspect the equipment or system during scheduled non-operational periods in order to find impending failure and accomplish repair or restoration of performance before failure occurs in a subsequent operational period. This maintenance includes the preflight and postflight inspections, and phase inspections as well as scheduled maintenance actions, such as non-destructive inspection, corrosion prevention. These maintenance actions occur on a regular basis either prior to a flying mission or immediately following the mission.

Prior to each flying mission, a preflight inspection is accomplished to ensure the aircraft is mechanically capable of flying the scheduled mission. If a system failure is detected during the preflight inspection, the aircraft is removed from the mission capable aircraft pool and sent to the unscheduled maintenance module. If no failures are detected, the aircraft is released to fly the mission. This inspection is done by the crew chiefs.

Immediately following a mission, a postflight or thruflight (depending on the remaining daily flying schedule) is accomplished and each aircraft is serviced (refueling etc.). If system failures are discovered the aircraft is removed from the mission capable aircraft pool and sent to unscheduled maintenance. In addition, following each mission a check is made based on the total flight hours the aircraft has been flown to see if phase maintenance is required. If phase maintenance is required the aircraft is removed from the mission capable aircraft pool and scheduled phase maintenance is performed. During phase maintenance, planned checks and part changes are being done by a maintenance crew based on total flight hours and total number of sorties. If no postflight failures are detected and phase maintenance is not scheduled, the aircraft remains in the mission capable aircraft pool and is available to fly.

Unscheduled maintenance is a corrective maintenance done to return the aircraft to a ready-to-fly status after a part has failed or has been reported malfunctioning. Unscheduled maintenance is performed when needed. When an aircraft enters the unscheduled maintenance module, these three possible actions can be taken: 1) the defective part can be repaired on the aircraft and the aircraft returned to mission capable aircraft pool, 2) The failure can not be duplicated and the aircraft is released, 3) The defective part is removed from the aircraft, replaced by a spare part, and the aircraft is released. If remove and replace action occurs, the removed part is sent to an in-shop facility where one of three possible actions can be taken: 1) The defective part is repaired in-shop and used as a spare for future remove-and-replace actions, 2) The defective part can not be repaired in-shop and is sent to the depot, 3) The defective part is bench-checked, no repair is required, and the part is released to the spares pool.

Once an aircraft has been released to the flying module, the flying module checks for daylight and clear weather conditions. If daylight and clear weather conditions are both present, then after completion of several prelaunch tasks the mission is flown.

The interaction of these three modules continue and together they make up the flight operations of one squadron. The aircraft maintenance specialties modeled are listed in appendix B.

Scenarios

There are two scenarios used for the analyses conducted in this study. A peacetime scenario is used to evaluate the impact of improved reliability and maintainability on manpower requirements and a wartime surge scenario is used in assessing mission capability impacts, number of mission capable aircraft and number of sorties flown.

Uncertainty about the true wartime demands for resources makes it important to evaluate the effects of R&M on readiness and mission effectiveness by focusing directly on generic wartime sorties. Because more aircraft are flying, more parts are subject to failure, and average time to repair increases as a result of queueing at repair stations. Each of these scenarios are described as follows.

Peace Time Scenario. The peace time scenario is based on a generic squadron of twenty aircraft with a daily required sortie rate of 1.0 (i.e an average of one sortie per aircraft per day). Flying is restricted to daylight, and clear weather must be present. Maintenance crews work two eight hour shifts per day except crew chiefs and a few other work centers, which work three eight hour shifts per day. The simulation model is based on twelve hours of daylight and weather conditions. The weather cancellation rates were not available for the location of the first F-16 base in Turkey. It is assumed here that there is no seasonal variation and bad weather occurs every 18-30 hours based on a uniform distribution and lasts 1.5 to

2.0 hours also based on an uniform distribution. This assumption can to match the weather characteristics of different locations.

During recent briefings on the maintenance system and supply activities, the NMCS rate was given as 6.5 or 7.0 percent for the USAF. Because of the different supply capabilities of the TUAF it assumed that this rate would be higher for the TUAF. Therefore, two aircraft are considered non-mission capable due to supptly shortage, providing a ten percent non-mission capable supply (NMCS) rate. Thus, 18 aircraft are available to fly if no unscheduled or phase maintenance is being performed.

Wartime Surge Scenario. A surge period of thirty days is modeled with the first seven days having no phase maintenance performed. There are no established sortie rates for a day, since during the surge period as many sorties as possible are desired. Maintenance crews work twelve hours shifts per day for the entire thirty days. The number of aircraft modeled and the weather conditions are the same as in the peace time scenario. The daylight hours are increased by two hours.

Because of the intensive utilization of the resources and facilities and combination of some phase inspection items, postflight time to taxi, and park and post/thru flight check time was reduced by .20 hours. The maintenance repair time for phase maintenance was reduced from a uniform distribution from 24-36 hours duration for peacetime to a uniform distribution from 5-8 hours duration for the wartime surge scenario.

A comparison of major factors for the two scenarios are summarized in Table I.

Table I

Comparison Of Major Factors
For Peacetime and Wartime Surge Scenarios

Factor	Peacetime	Wartime Surge
Sortie rate	20/day	no limit
Number of Aircraft	20	20
Number of work centers	18	18
Daylight Hours	12.0/day	14.0/day
Average sortie length	2.0 hours	2.0 hours
Taxi-in and park time	0.4 hours	0.2 hours
Post/thruflight inspection	0.4 hours	0.2 hours
Phase length day 1-7	24-26 hours	None
Phase length day 8 t0 end	24-26 hours	5-8 hours
Shift lengths	8.0 hours	12.0 hours
Weather Conditions	same for both	

Measures of Merit

The first measure of merit is the number of sorties that can be flown in a designated period of time. The analysis of the sorties will be based on the 30 day wartime surge scenario. This measure is significant because the primary mission of an aircraft maintenance system is to keep the aircraft flying. A drawback of this measure is that one aircraft can fly several sorties while other aircraft are non-mission capable. Therefore, there is a need for other measures such as number of mission capable aircraft, and maintenance manpower resouces required.

The second measure of interest is the average number of mission capable aircraft. While the number of sorties flown is dependent on available aircraft, sorties can be influenced by factors not directly controlled by the aircraft maintenance system such as weather conditions. The number of mission capable aircraft provides a measure fully controlled by the aircraft maintenance system.

The third measure of merit is the number of maintenance manpower resources required to provide a desired sortie rate. This factor is a function of crew size, specialty structure, failure rates and repair times. This measure is particularly important from a cost and resource availability standpoint to help defense decision makers make tradeoffs more efficiently among manpower and other kind of resources.

III. Model

Model Overview

The model established in this research is of flight operations consisting of two major activities, flying activities and maintenance activities. It is based on a generic fighter squadron of twenty aircraft. Simulation Language for Alternative Modelling (SLAM)(10) is used for simulation modelling. SLAM is a high level, FORTRAN-based simulation language which allows an event-scheduling or process-interaction orientation, or a combination of both approaches (11:99). The process-interaction orientation of SLAM uses networking concepts to model a system. Nodes and branches represent parts of a system such as decision points, queues and maintenance activities. Entities, such as aircraft in this case, then flow through the network.

The model in this research is a simulation network model which consists of three major network segments and three network modules. It was developed on the VAX 11/785 VMS computer system. The three major model segments are the sortie generation, unscheduled maintenance and phase maintenance segments. The model is a macro model with work unit codes at the two-digit level (identification of major subsystems of an aircraft such as airframe, landing gears, engine, etc.). These major subsystems are listed in appendix A. Maintenance tasks are grouped into categories of scheduled maintenance (e.g preflight, post/thruflight, phase maintenance) and unscheduled maintenance that includes remove and replace actions and repairs performed both on aircraft and in-shop. The interaction of these three major network segments is shown in Figure 2.

Model Structure

The sortie generation segment of the model includes all flight activities and branches to the other model segments. There are interactions between the major network segments and three supporting network modules. Three modules within the sortie generation segment limit flying to daylight and clear weather, and change maintenance crew sizes in work centers at shift changes.

The model structure can be described as follows. A squadron of twenty aircraft is created. Each aircraft has twenty-three major subsystems and four scheduled phase maintenance points associated with it. Failure clocks based on number of sorties flown for the twenty-three major subsystems and flying hours for the four phases are assigned as attributes of that specific aircraft. Once created the aircraft will enter the scheduled maintenance preflight activity. The preflight check is done by crew chiefs. When the preflight check is completed, the aircraft will be

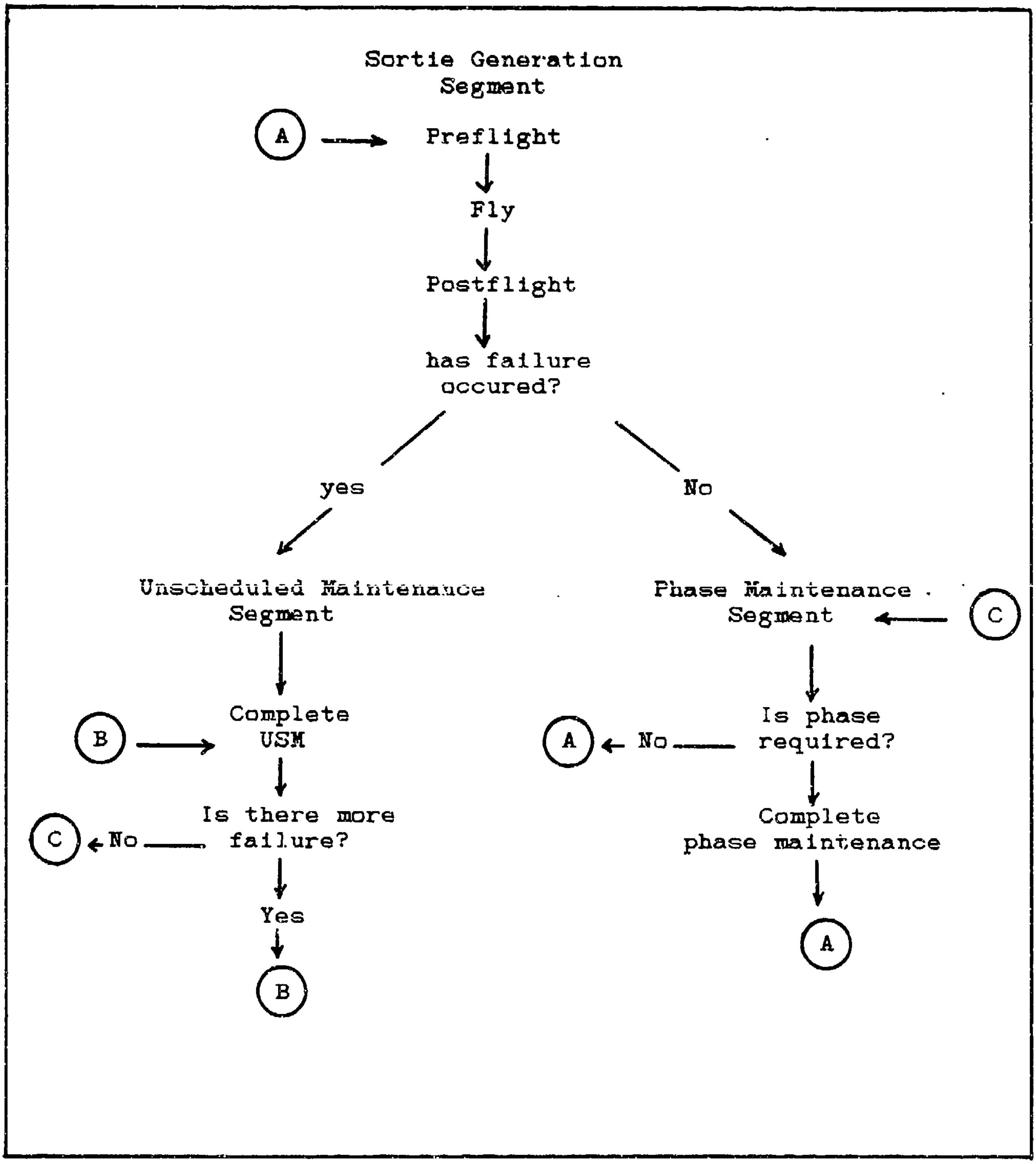

Figure 2. Major Model Network Segments

and relationship

released to fly. Before flying the sortie, two conditions must be met. If either or both daylight and clear weather conditions are not met the aircraft waits for daylight and clear weather (i.e waits until both conditions are met). If these conditions are met, the aircraft proceeds through prelaunch activities (taxi out, take-off controls etc.) and flies the scheduled sortie. The length of the sortie is randomly set based on a normal distribution mean of two hours and variance of one half hour.

After returning from a sortie, the failure clocks for the twenty-three major subsystems are decremented by one and the phase maintenance clocks are decremented by the length of the sortie. The scheduled maintenance post/thruflight check is performed and the number of daily sorties flown increased by one. A check is made based on the value of the clocks after post sortie decrementing to determine if a system has failed or if scheduled phase maintenance is required. If neither has occurred and if it is still daylight, the aircraft is released to fly. If daylight has expired, the aircraft is sent to preflight to prepare for the next day's flying. For the peacetime scenario, the total number of daily sorties flown are checked with a desired daily sortie rate and if this rate has been met, flying activities are finished for this particular day.

If a system failure is detected, the aircraft is sent to the unscheduled maintenance segment. It is declared non-mission capable and placed in a queue which represents the maintenance work center appropriate to the failure. There it waits the availability of the maintenance crew. The model utilizes eighteen maintenance work centers with a separate queue for each. When a maintenance crew becomes available, the repair action is completed either on aircraft or by removing the failed component and replacing it with a spare part. After completion of repair action the maintenance crew and aircraft are released. The failure clock is reset and a check is made to see if any more failures are present. If no more failures exist, the aircraft is designated mission capable and released for preflight check. If a second failure is detected, the above process is repeated.

If a component was removed during the unscheduled maintenance action, this component is sent to an in-shop repair network. This repair action has no impact on the availability of the aircraft and is therefore not significant for determining the number of mission capable aircraft or the number of sorties flown. However, it is significant for determining manpower resource requirements. At the in-shop network, the component waits for an available maintenance crew. Then, it is either repaired and replaced in the spares pool or sent to depot level maintenance. If the component is not repairable, it is bench-checked and sent to a unrepairable parts pool.

If phase maintenance is scheduled, the aircraft is declared non-mission capable and placed into the phase maintenance network for a specified period of time. Following the completion of phase maintenance, the flying hours clock for that aircraft is reset, the aircraft is released to the mission capable aircraft pool and sent to preflight.

Figure 3 shows the unscheduled and phase maintenance network segments. Appendix B contains the SLAM and FORTRAN code for the model, user information, and sample model output.

Input Data and Model Variables

There are two major sources of data for this model. These are the Production Distribution Computer Lists from the Hill AFB maintenance organization data control center and the LCOM computer data from ASD/ENSSC. These data include one year flight period historical data for 34,999 flying hours and 25,023 sorties.

The distributions for time between failures (TBF) and time to repair (TTR) are based on distributions used by the LCOM model (12:3-30). The failure rates for unscheduled actions for the twenty-three major subsystems are based on an exponential distribution. The mean (u) of the distribution is the number of sorties between failures for each of the twenty-three major subsystems. This data is provided on the Production Distribution Computer Lists as an average number for each of the twenty-three major subsystems. These average numbers are used as a mean of exponential distributions for

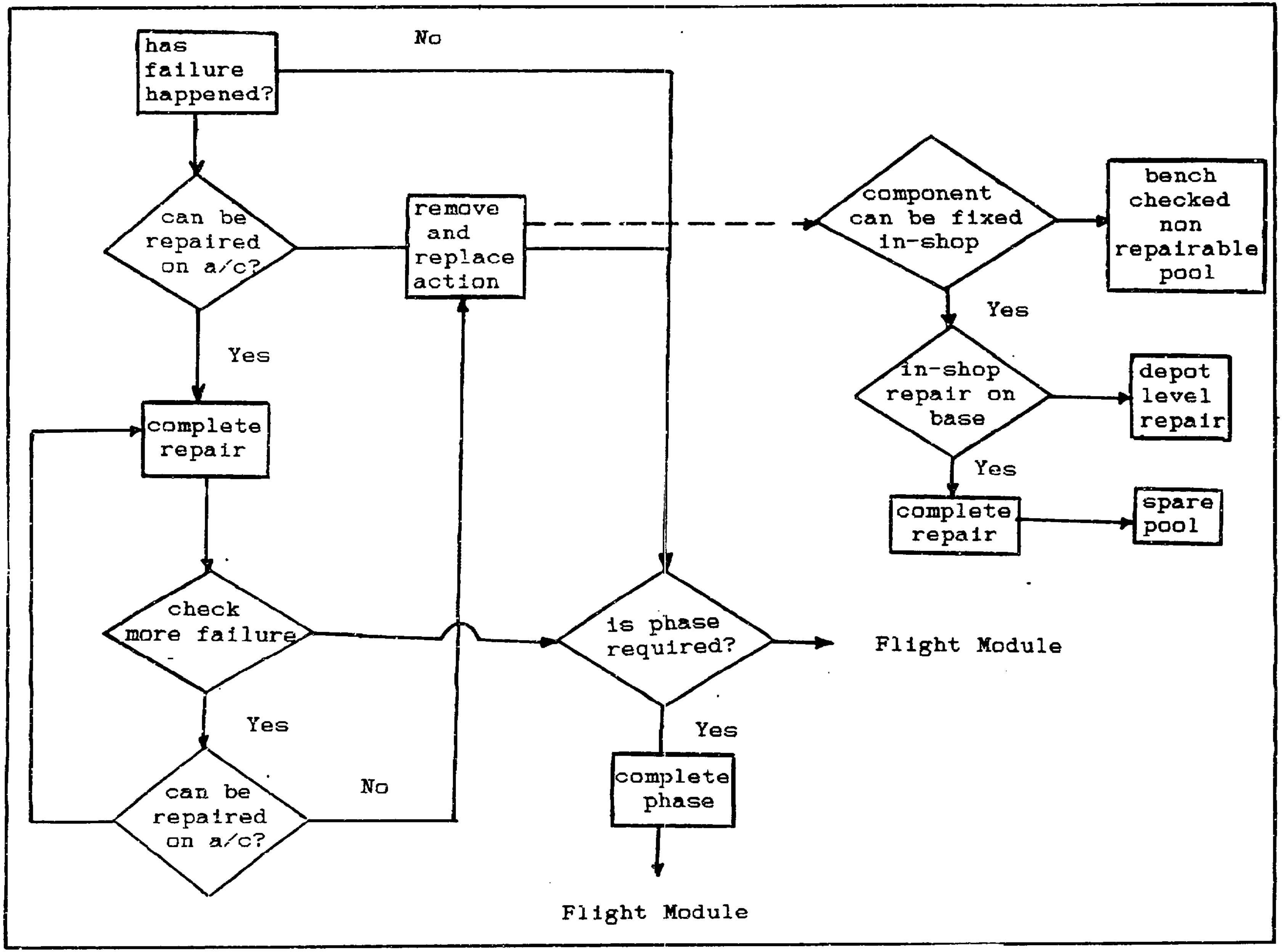

Figure 3. Unsheduled and Phase Maintenance Segments

the failure rates. Appendix A contains the failure rates for each system modeled.

The repair times are based on a lognormal distribution with parameters mean and variance. The task repair times are available on LCOM computer data for each subsystem. For this model, the task repair times were weighted based on the frequency that the subsystem failed per sortie. These weighted subsystem repair times were summed to obtain a mean time to repair for the overall system. An example of this computation is shown in Table II. In the example, the frequency that each subsystem failed per sortie is shown in column two. These are summed to compute a total frequency for the overall system (0.0281). Column three contains the percent of the overall frequency that is attributable to each subsystem (e.g 0.0060/0.0281 = 0.21). The subsystem task repair times (column four) are weighted by these percentages to obtain a weighted task repair time for each subsystem (column five). These are summed to obtain a major subsystem mean time to repair (1.821). This value was used as the mean for the lognormal distribution used to generate repair times. The variance of the distribution is based on 29 percent of mean. Historically, the 29 percent figure has been used in the LCOM model(13:41). For the above example, the variance would be (1.821)(0.29) = 0.528. Therefore, the repair time for the example would be based on a lognormal distribution with mean of 1.821 hours and variance 0.528 hours.

Table II

Example Computation of Mean to Repair

Sub System	Frequency Per Sortie	% of total Frequency Per Sortie	Weight	Task Repair Time	Weighted Time
11A	.0060	21	.21	1.3	.273
11B	.0112	39	.39	2.2	.858
11C	.0073	25	.25	1.8	.450
11D	.0036	15	.15	1.6	.240
	.0281				1.821

Manpower Baseline

A manpower (resource) baseline was established for each of the twenty-three work centers modeled in the simulation to support one sortie per aircraft per day (1.0 sortie rate). Initially the model was run with unlimited resources (200) for each work center, resulting in no waiting time for manpower. The number of positions required in the model for each center was then determined by multiplying the SLAM provided average utilization rate of each resource times the number of simulated hours (6248) minus a warm-up period of 240 hours. This calculation provided the total yearly manhours expended by each resource. This figure was then divided by twelve to obtain an estimate of total monthly manhours. Using a monthly manhours factor of 168 hours for one unit of resource (21 workdays X 8 hours per day), the total monthly manhours were divided by 168 to obtain a model manpower requirement for each work center. If this value was less than minimum crew size, then it was rounded up to the minimum crew size.

This procedure was repeated for each work center and these resource levels were entered into the model. The model was then run to see if the desired 1.0 sortie rate (20 sorties per day) could be achieved. If the sortie rate was met, these resource levels were considered as the minimum resource levels and were retained in the model. However, if the desired sortie rate was not met, resource levels were increased for selected work centers based on longest waiting time and longest queue length. The model was then rerun to see if the desired sortie rate was met. This procedure continued until desired sortie rate was achieved and these resource levels were used as the baseline model resource requirements. The baseline manpower levels for the modeled work centers are contained at Table III.

Since there are no differences between available manpower resources for the peacetime and wartime, the baseline manpower resource levels were used for both peacetime and wartime surge scenarios.

Assumptions

The following assumptions were made in the development of the simulation model by leaving something out of the scope of the model or in determining the working details of the model.

Table III
Modeled Work Centers and Manpower Requirements

AFSC	Name	Requirements
326X4	Int. Avionics Comp Test Stn.	12
326X6	Int. Avionics Attack Cont Sys.	62
326X7	Int. Avionics Instm & Flt Cont.	20
326X8	Int. Avionics Comm, Nav, & Pen-Aids	24
404X1	Photo & Sensor	8
423X0	Electrical System	18
423X1	Environmental System	6
423X2	Egress System	6
423X3	Fuel System	20
423X4	Pneudraulic System	14
426X4	Jet Engine	20
426T4	Jet Engine Test Cell	4
427X3	Fabrication & Parachutte	4
427X4	Metals Processing	4
427X5	Airframe Repair	4
431F1	Crew Chief	48
431R1	Tac. Act Maint. Specialist	14
462X0	Munitions System	12
Total		298

Any analysis performed using this model should take these assumptions into consideration.

1. Sorties are only flown during daylight.

2. The flight time may be different for different type of mission (air-to-air, air-to-ground, training). However, no empirical data were available. Therefore, the average assigned mission flight time is used in the model.

3. Pilots were not considered as a resource.

4. The model does not simulate the spare parts available or used during a repair action. The model assumes that

spare parts are available when needed. Because of the complexity of resupply and cannibalization issues, an approximation of the effect of spare parts on operational readiness can be made by subtracting the historical percentage of aircraft not mission capable due to supply. To account for NMCS time, two aircraft were removed from the system. This equates to a (2/20)X 100 = 10 percent NMCS rate.

5. Failure clocks are checked after each flight. Ground abort and air abort rates are not taken into consideration. It is assumed that these two rates are not significant because they are small.

6. Unscheduled maintenance and phase maintenance are modeled sequentially. Multiple failures are repaired sequentially. Some maintenance activities such as those involving the fuel system are not allowed to be done concurrently with any other repair due to safety. The aircraft maintenance system is modeled at the two-digit work unit code(system) level. When modeling at the two-digit level, the parallel failures that occur within a subsystem are handled in the aggregated failure rate.

7. Multiple failures are repaired from lowest WUC to highest, because of the way failures are determined.

8. If two or more aircraft are waiting for a particular work center, the aircraft that has been

waiting the longest time is repaired first.

9. A repair crew works until finished with a job. This will cause some crews to work past shift change.

10. Aircraft attrition rate is assumed to be zero.

11. The statistical distributions used in LCOM model are assumed valid in describing the random behavior of the reliability and maintainability factors in the aircraft maintenance system.

Limitations

The purpose of this model is to evaluate the effects of reliability and maintainability. The model should not be used to determine total manpower requirements for a specific squadron. Some secondary workload is not modeled (e.g non-destructive inspection, corrosion control), since only specific maintenance work centers were of interest. In addition, substitutability, cross training, guest aircraft services, skill levels, predictions on the number of maintenance people on leave, at training, or on temporary assignment to other jobs, or people that are performing management and administrative functions were not taken into consideration in manpower baseline requirements. Therefore, the total resource requirements indicated by the model are applicable only to those work centers modeled. Large models such as LCOM, TSAR, should be used for overall manpower determination.

The scenarios and aircraft used in this study for analyses are specific. For example, although the data used in this model is primarily F-16 data, the scenario is very general due to the reduced number of maintenance actions and maintenance work centers modeled. Therefore, the output related to this model can be considered applicable to a generic tactical fighter squadron used in the scenarios previously outlined. Any predictions for a specific aircraft would require the input of reliability and maintainability levels specific to that aircraft. In addition, the unscheduled maintenance network may require addition or deletion of system networks.

Verification and Validation of the model

Verification is the process of assuring that the simulation program actually behaves as the programmer intended. Verification is the comparison of the conceptual model to the computer code to see if the code actually reflects the flow and logic of the conceptual model (11:375). Validation is the process of determining the model accurately portrays the real system (10:10). The subtle difference between verification and validation is that the former is the comparison of a model to the designer's intentions while the latter is the overall comparison of a model to the real system.

Verification. This model was verified through the use of some common sense techniques such as trace listing, collecting statistics on critical model activities, etc.

The model was consructed module by module, and after adding a new module to the main program a check was made to see if the module behaves correctly. For example, the addition of the weather module to the main program caused a decrease in the total number of sorties flown.

Trace listing is showing how the aircraft entities move through the SLAM networks. The trace is a built in ability of SLAM to verify the path of entities through the nodes and activities. The trace listing revealed that the aircraft moved through SLAM network as intended. The following are examples of observed network flows. Aircraft were given preflight, flew a sortie, stopped at night, and then began this cycle again. Phase inspections were completed at appropriate times. Aircraft were checked for failures and routed correctly if a failure had occurred. In addition, aircraft with multiple failures were sent to repair cycles until all failures were fixed. Shift changes occurred at the appropriate times.

The SLAM summary reports were examined by checking the statistics on critical model activities for indications of problems such as unexpected waiting times and destruction or creation of aircraft entities. A sample of SLAM output is included in appendix B. For example, the number of aircraft leaving the two exit points of the failure network equaled the number of aircraft entering this network. The number of aircraft entering the unscheduled maintenance module equaled the total number of aircraft requiring on aircraft repair action or remove and replace action. The number of components going to in-shop repair was also equal to the number of aircraft requiring remove and replace action. Another example is that all aircraft flying a sortie received a thru/postflight inspection. Therefore, the number of sorties flown should be equal to the number of aircraft that receive thru/postflight inspection. Similarly, each branch node was tested to make sure that the number of entities leaving the node was equal to the number of entities entering the node.

Another step was to verify the model variables were functioning as designed. This was accomplished by changing these variables and observing the changes to output statistics dependent on these variables. For example, when the reliability rate was improved, the number of sorties flown increased from 1366 to 1556 for the wartime surge scenario. When a 1.0 sortie rate was set, 5040 sorties were flown in one year (20 sorties per day, 21 days a month).

The accuracy of representation of the conceptual model was also checked by the thesis advisor by checking the computer codes.

<u>Validation</u>. Validation of the model is a more difficult task. Ideally, a model can be validated by using historical inputs and then comparing the model outputs to the

real system outcomes. Since the TUAF has no experience with the F-16 aircraft, there is no historical data that can be used. Therefore, validation efforts were aimed at considering the reasonableness of the model outputs for the given inputs - the face validity of the model. The observed output values were determined to be near the expected values for such measures as number of mission capable aircraft and total number of sorties flown. In addition to checking the reasonableness of the model outputs, the model calibration process took a major part in the validation. "Calibration is the iterative process of comparing the model to the real system, making adjustment to the model. The comparison of the model to reality can be carried out by a variety of tests. Subjective tests usually involve those who are knowledgeable about one or more aspect of the system making judgments about the model and its output" (11:383). As an aircraft maintenance officer, the author was able to apply this calibration process to the model. As an example, in early runs of the model the minimum number of mission capable aircraft was becoming zero. When trace listings were checked, it was found that too many aircraft were coming to the phase maintenance point at the same time. A modification was made to stagger the phase maintenance point by changing the beginning flight hours distribution for phase maintenance to decrease this number.

The completion of the above processes increased the face validity of the model. Model results will be presented in the next chapter. For full validation, the model still requires historical data as an input from the TUAF with the F-16 experience.

Summary

The flight operations of one generic fighter squadron is modeled by using SLAM. This flight operations consist of two major activities, flying activities and maintenance activities. Maintenance activities grouped into two categories: unscheduled maintenance and phase maintenance.

One year's historical data from Hill AFB, Utah was used as an input for model variables. Using SLAM utilization rates, model manpower baseline was established for both peacetime and wartime surge scenarios. A variety of assumptions were used in the model construction in determining the rking details of the model.

Finally, verification and validation of the model were discussed. The model was verified through the use of trace listings and SLAM summary reports. Validation was difficult, since the TUAF has no experience with the F-16 aircraft. However, the reasonableness of the model output values was checked and a calibration process was used in establishing face validity of the model.

IV. Analyses and Results

Reliability impacts on manpower requirements

Approach. The baseline resource levels established in chapter III were developed using baseline mean failure rates and mean repair times from previously referenced sources.

The reliability rates were then increased by 25 percent and the procedure described before for determining manpower requirements was repeated. This established the manpower requirement for the new reliability criteria while maintaining the desired daily sortie rate of 20 sorties (one sortie per aircraft per day). These manpower levels were compared to the baseline manpower requirements and the percent of change was computed. The baseline reliability rates were then increased by a factor of two and the procedure for determining manpower requirements was repeated. Once again, these manpower levels were compared to the baseline manpower requirements and the percent of change was computed. The results of this experiment are detailed below.

Results. The baseline manpower requirement was established at 298 manpower authorizations. A 25 percent increase in reliability resulted in a manpower requirement of 280 manpower authorizations. Therefore, a 25 percent increase in reliability requires 6.04% less manpower to maintain a desired 1.0 sortie rate. A twofold increase in reliability required 218 manpower authorizations to maintain the desired sortie rate. Thus, a twofold increase in reliability requires 26.8% less manpower to maintain the same sortie rate. Detailed results of this analysis are contained in Table IV. These requirement levels and potential decreases in manpower requirements are only applicable to the work centers modeled and these percentages can not be extrapolated across the entire maintenance organization.

Table IV

Model/Manpower Requirements For Various R&M Levels

Speciality Code	Baseline Requirement	25% Increase	Twofold Increase
326X4	12	11	8
326X6	62	56	42
326X7	20	17	12
326X8	24	21	16
404X1	8	8	8
423X0	18	18	12
423X1	6	6	6
423X2	6	6	6
423X3	20	18	12
423X4	12	12	10
426X4	20	18	14
426T4	4	4	4
427X3	4	4	4
427X4	4	4	4
427X5	4	4	4
431F1	48	48	36
431R1	14	14	12
462X0	12	11	8
Total	298	280	218
Percent Decrease		6.04%	26.8%

R&M Impacts On Mission Effectiveness

Approach. A full factorial analysis was performed to quantify the effect of reliability and maintainability on the number of mission capable aircraft and the number of sorties flown.

Factorial Design. A Factorial design is the most efficient experiment to evaluate the factor effects on the response variables. By a factorial design all possible combinations of the levels of the factors and the interactions of the factors can be examined (14:189-192). In this research factorial analysis was performed with the reliability and maintainability factors at two levels and crew size at three levels. Improved reliability is frequently discussed in terms of twofold and fourfold increases. Therefore, baseline reliability levels and twofold increase were used for this experiment. Maintainability is often discussed in conjunction with reliability, but no specific levels of interest were identified in the literature. Thus, a subjective decision was made to test the levels of the maintainability at the current level and with a one-third reduction in mean time to repair. Crew size was established at three levels - baseline manpower requirements, 20% increase and 20% decrease in baseline manpower requirement. The three factors and the levels used are summarized in Table V.

Table V

Levels of Factors Used In Factorial Design

Factor	Level1	Level2	Level3
Reliability	Baseline	Twofold increase	---
Maintainability	Baseline	33% decrease	---
Crew Size	Baseline	20% increase	20% decrease

Number of Replications. It is possible to obtain a value of an output variable such that it estimates the true population value within some accuracy criterion with a high degree of probability. This can be done by determining, based on the initial sample values, the number of observations that will provide the desired accuracy. The number of observations required is determined by the following formula (6:427):

$$N \geq \left[\frac{(t_{a/2,N-1}) \cdot (S)}{e} \right]^2 \qquad (1)$$

where

N	is the number of observatins required,
$t_{a/2,N-1}$	is the t-statistic for confidence level a/2 and N-1 degrees of freedom,
S	is the standard deviation of the sample, and
e	is the half-width of the desired confidence interval.

A confidence level of 95% (a = 0.05) and half-width of 0.2 is used. The half-width 0.2 gives an estimate of the number of mission capable aircraft within 98% accuracy. With an initial sample size of five pilot runs to estimate the population variance, the computation in formula (1) results a value of N = 2.12. Therefore, twelve runs (2X2X3) with three replication for each were made and the average number of mission capable aircraft and the average number of sorties flown were collected for each run. This data was used as an input to the SAS statistical package General Linear Model (GLM) procedure (15:433) and a full factorial analysis was performed.

The SAS input data and execution program are included in appendix C. The ANOVA results are shown in Table VI and Table VII where the factors are: a=reliability, b=maintainability, and c=crew size.

Correlated sampling using common random stream (16:507) was used as a variance reduction technique. To implement sychronized common random streams, a separate random number stream was assigned to the unscheduled maintenance, phase maintanance, sortie generation segments, and the input variables. At the begining of each replication, a new and independently chosen set of seeds was specified, one seed for each random number stream. The same common random number streams were used when the factor levels were changed.

Table VI

Analysis of Variance for Dependent Variable
Average Number of Mission Capable Aircraft

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Pr > F
a	33.56271	1	33.56271	1968.81	0.0001*
b	16.53777	1	16.53777	970.12	0.0001*
c	0.09017	2	0.04508	2.64	0.0916
ab	0.73387	1	0.73387	43.05	0.0001*
ac	0.40350	2	0.20175	11.83	0.0003*
bc	0.06353	2	0.03176	1.86	0.1769
abc	0.06367	2	0.03183	1.87	0.1763
Error	0.40913	24			

a = reliability b = maintainability c = crew size
* Significant at 1 percent

Table VII

Analysis of Variance for Dependent Variable
Average Number of Sorties Flown

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Pr > F
a	179352.25	1	179352.25	1399.06	0.0001*
b	84196.69	1	84196.69	656.79	0.0001*
c	177912.72	2	88956.36	693.92	0.0001*
ab	11130.25	1	11130.25	86.82	0.0001*
ac	8190.50	2	4095.25	31.95	0.0001*
bc	3296.05	2	3296.05	12.86	0.0001*
abc	641.16	2	320.58	2.50	0.1032
Error	3076.66	24			

a = reliability b = maintainability c = crew size
* Significant at 1 percent

A normal probability plot for residuals and plots for residuals versus number of mission capable aircraft and the number of the sorties flown were checked for model adequacy. There was no unusual structure apparent. These plots are shown in appendix C.

Results. At the 99% confidence level, reliability, maintainability, and the interactions between reliability and maintainability and between reliability and crew size have a significant effect on the average number of mission capable aircraft. All factors and the two-way interactions of the factors have a significant effect on the number of sorties flown.

Using this data, the percentage increase in the average number of mission capable aircraft and the average number of sorties flown for each treatment combination of reliability and maintainability were computed and summarized in Table VIII.

Consolidation Impact On Manpower Requirements

Background. In the USAF, the Project Rivet Workforce initiative is accepted with the overall objective of creating a more flexible, mobile, and survivable work force which meets future employment concepts and maximizes training and utilization. One of the specific methods is to combine similar technology career fields into one group and to achieve this objective. Several aircraft maintenance specialists have been recommended as candidates for consolidation (18:Section 18).

Table VIII

Percent Change In Sorties and Mission Capable Aircraft For Each Treatment Combination

Treatment Level		Dependent Variable			
Rel	Maint	Mission Capable Aircraft	Percent Change	Sorties	Percent change
1	1	12.56		1356	
1	2	14.27	13.6	1486	9.5
2	1	14.75	14.7	1547	14.0
2	2	15.73	25.2	1605	18.3

Rel level 1 = baseline
Rel level 2 = twofold increase
Maint level 1 = baseline
Maint level 2 = .33 decrease

The model developed in this research has the capability to analyze the effect of consolidation of specialties on manpower requirements. Such consolidation of specialties may be of interest to TUAF decision makers in the implementation phase of the F-16 aircraft. The experiment described below represents a hypothetical consolidation of specialties.

Approach. This analysis examined the impact of consolidating the flight line integrated avionics specialties 326X6, 326X7, and 326X8 into a single specialty

326XX as might be done under a program like Project Rivet Workforce.

The peacetime scenario was used and throughout the model the specialties were modified as described above. The baseline reliability and maintainability levels were used and the procedure to determine the manpower requirements was repeated. Manpower requirements after consolidation were compared to the baseline manpower requirements and the percent change in the manpower requirements were computed.

Results. The baseline manpower requirements were 298 manpower authorizations. The consolidation analysis resulted in a manpower requirement of 276 manpower authorizations. As a result of consolidation of the three avionics specialties, there was a 7.3% decrease in the total manpower requirements and 20.7% decrease in the total of 326X6, 326X7, and 326X8 specialties requirements. The result of this analysis is contained in Table IX.

Table IX
Consolidation Experiment Results

Speciality Code	Baseline Requirement	Consolidation	
326XX	---	84	*
326X4	12	12	
326X6	62	---	*
326X7	20	---	*
326X8	24	---	*
404X1	8	8	
423X0	18	18	
423X1	6	6	
423X2	6	6	
423X3	20	20	
423X4	12	12	
426X4	20	20	
426T4	4	4	
427X3	4	4	
427X4	4	4	
427X5	4	4	
431F1	48	48	
431R1	14	14	
462X0	12	12	
Total	298	276	
Percent Decrease		7.3%	

* Consolidated specialties

V. Conclusions and Recommendations

The research effort of this thesis followed the methodology as stated in chapter I. After some brief information about Combat Oriented Maintenance Organization, the operational structure was discussed. A SLAM simulation model for the flight operations of one generic fighter squadron was developed. Verification and validation were then conducted to evaluate the model's ability to accurately describe true behavior of the system.

Conclusions. Based on the verification and validation efforts for this model, it can be concluded that the simulation model developed is a useful macro-level planning tool for making decisions related to reliability and maintainability and can also be used to evaluate other aircraft maintenance initiatives, such as consolidation of maintenance specialties. Due to the manner in which this model has been constructed, it is a flexible model that can be easily adapted to different aircraft. From the analyses outlined in chapter IV, specific conclusions can be drawn by summarizing the results of these analyses.

The analyses indicated that reliability has a significant effect on the average number of sorties flown and the average number of mission capable aircraft. A twofold increase in reliability resulted in a 14% increase in sorties flown and a

17.4% increase in the average number of mission capable aircraft. In addition to the changes in the mission effectiveness measures, a 25% increase in reliability will reduce the maintenance manpower requirements by 6.04% and a twofold increase in reliability will reduce the maintenance manpower requirements by 26.8%.

Maintainability has a significant effect on the number of sorties flown and the average number of mission capable aircraft. A 33% reduction in the mean time to repair will increase the number of sorties flown by 9.58% and the average number of mission capable aircraft by 13.6%.

The interaction between reliability and maintainability has a significant effect on the number of sorties flown and the average number of mission capable aircraft. A twofold increase in reliability and a 33% reduction in maintainability together will increase the average number of sorties flown by 18.3% and the average number of mission aircraft by 25.2%.

Crew size was determined to be statistically significant in predicting the number of sorties flown, however, from a percent change viewpoint the effect is relatively small when compared to reliability and maintainability impacts. The percent change in the average number of sorties flown was 2%. Crew size was not significant in predicting average number of mission capable aircraft.

The consolidation analysis indicates that consolidation of certain maintenance specialities has the potential to reduce maintenance manpower requirements at a level similar to reliability and maintainability.

As indicated above, while reliability and maintainability do have significant effects on maintenance manpower requirements, similar results can be achieved through productivity enhancements such as consolidation. However, the improvements in mission capabilities shown in this research by improving reliability and maintainability have a significant effect on war-fighting capability and should be considered a critical factor in weapon system acquisition.

While reliability has been shown to be the most significant factor, improved maintainability can be used to achieve desired results and can be an alternative to unachievable reliability improvements.

Recommendations. There are two areas that the model has the potential to be used for future studies. First, the model might be used to analyze pilot training requirements for the F-16 implementation by the TUAF, with modification of the sortie generation segment of the model. The focus of the model would be different and would have to incorporate the pilot training schedule.

Second, the model assumes that spares are available when needed. The effects of the spares may be of interest. The model could be expanded to five-digit level in terms of WUC to include these consideration. Model could examine spares inventory levels and needs for a designated period of time.

Appendix A

Input Data

This appendix contains the input data used in the model for reliability and maintainability factors. Table A.1 contains the parameters of the lognormal distributions used to compute unscheduled maintenance repair times for each system subdivided into on-aircraft repairs, remove and replace actions, and in-shop repairs. Table A.2 contains the parameters of the exponential distributions used to compute the failure rates for each system. The following codes are used in the tables.

OA = On-Aircraft Repair
RR = Remove and Replace Action
SR = In-shop Repair
UM11 = Airframe
UM12 = Crew Station System
UM13 = Landing Gear
UM14 = Flight Control System
UM23 = Turbofan Power Plant
UM24 = Auxliary Power Plant
UM41 = Enviromental Control System
UM42 = Electrical Power System
UM44 = Lighting System
UM45 = Hydrolic and Pneumatic System
UM46 = Fuel System
UM47 = Oxygen System
UM49 = Miscellaneous System
UM51 = Flight Instrument
UM55 = Malfuntion Analy. and Recording Equip.
UM62 = VHF Communication
UM63 = UHF Communication
UM64 = Interfone System
UM65 = IFF System
UM71 = Radio Navigation
UM74 = Fire Control System
UM75 = Weapons Delivery
UM76 = Penetration Aids and ECM

Table A.1

Unscheduled Maintenance Repair Times

System Code	Type of Repair	Lognormal Distribution Mean	Lognormal Distribution Variance
UM11	OA	2.457	.712
	RR	5.420	1.571
	SR	12.085	3.504
UM12	ON	3.211	.931
	RR	4.043	1.172
	SR	3.260	.945
UM13	OA	3.672	1.064
	RR	4.789	1.388
	SR	.587	.170
UM14	OA	6.684	1.938
	RR	7.040	2.041
	SR	6.600	1.914
UM23	OA	14.450	4.190
	RR	14.900	4.321
	SR	7.174	2.080
UM24	OA	5.152	1.494
	RR	8.420	2.441
	SR	11.620	3.396
UM41	OA	2.879	.834
	RR	5.839	1.693
	SR	2.748	.796
UM42	OA	2.652	.795
	RR	4.882	1.415
	SR	6.120	1.774
UM44	OA	2.158	.625
	RR	1.818	.527
	SR	6.246	1.811
UM45	OA	2.870	.832
	RR	5.087	1.475
	SR	9.858	2.858
UM46	OA	5.145	1.494
	RR	6.004	1.741
	SR	6.751	1.957
UM47	OA	2.367	.686
	RR	1.152	.334
	SR	2.136	.619
UM49	OA	2.150	.623
	RR	7.000	2.030
	SR	2.356	.684
UM51	OA	3.585	1.039
	RR	3.910	1.133
	SR	7.608	2.204

UM55	OA	2.372	.687
	RR	1.707	.495
	SR	6.178	1.791
UM62	OA	2.682	.777
	RR	3.160	.916
	SR	8.562	2.482
UM63	OA	1.924	.557
	RR	2.458	.738
	SR	6.192	2.004
UM64	OA	3.519	1.020
	RR	4.352	1.262
	SR	7.692	2.230
UM65	OA	1.940	.562
	RR	2.830	.820
	SR	8.890	2.578
UM71	OA	2.660	.771
	RR	3.078	.892
	SR	9.108	2.641
UM74	OA	2.996	.868
	RR	3.792	1.099
	SR	9.578	2.777
UM75	OA	4.251	1.232
	RR	3.255	.943
	SR	8.120	2.354
UM76	OA	3.925	1.138
	RR	4.202	1.218
	SR	9.160	2.656

Table A.2

MTBF in Sorties

System Code	Exponential Distribution Mean
UM11	7.57
UM12	39.60
UM13	7.95
UM14	16.30
UM23	23.10
UM24	18.00
UM41	48.90
UM42	41.70
UM44	21.60
UM45	65.10
UM46	20.20
UM47	60.20
UM49	804.70
UM51	59.20
UM55	433.30
UM62	50.50
UM63	67.00
UM64	433.30
UM65	65.80
UM71	229.00
UM74	11.30
UM75	24.20
UM76	29.10

Appendix B

Simulation Model Code

This appendix contains the simulation model developed for this research. General user information is provided along with the SLAM and fortran code that makes-up the model. In addition, a sample extract of the output file is provided to give the user an idea of what information is available from the model.

User Information

The model is written to represent a one year simulation with a ten day warm-up period. There are six variables that can be changed to accomodate changes in the scenario and the input parameters. The first variable is designated XX(1) and represents the number oi sorties that have been flown at the start of the simulation. For the analysis performed in this research, XX(1) was set to zero. The second variable is designated XX(2) and is used to change the mean time between failures. To increase the reliability level bv a given amount, XX(2) should be set to the multiple increase desired. In this research, the variable was set at 1, 1.25, and 2 to represent the baseline, 25% increase and twofold increase, respectively. Without the capability provided by this variable, the user would have to change the failure rates each place they occur in the model.

The third variable is designated XX(3) and is used to change the mean of the lognormal distributions used for the repair times by a given factor. To decrease the mean time to repair, XX(3) should be set at 1-R where R represent the percent of decrease. In the analysis performed in chapter IV, XX(3) was set at 1-0.33, with 1-0.33 representing a 33% decrease in repair times. Once again, without the capability provided by this variable, the user would have to enter the model and change each repair time individually.

The fourth variable XX(4) is used to set the desired sortie rate for the scenario being used. This factor is changed by the model during the simulation based on whether the desired sortie rate is met. For the peacetime scenario used in this research, XX(4) was set at 20 to represent 20 sorties per day or a 1.0 sortie rate based on one sortie per day per aircraft for 20 aircraft. For the wartime surge scenario, XX(4) was set equal to 200 to represent a 10.0 sortie rate per day per aircraft for 20 aircraft. The next variable is XX(5) and represents the number of mission capable aircraft available at the initilization of the model. This variable is also changed by the model as aircraft enter the unscheduled and phase maintenance networks. For this research, XX(5) was set equal to 18 to represent a 20 aircraft squadron with two down awaiting supply and therefore non-mission capable. The last variable is XX(29) and represents the percent of the mean that is used for the variance in the lognormal distributions used for the repair times. For this research, XX(29) was set at 0.29 for all repair times.

Any other changes desired by the user will require entering the model and making the changes where the factor is being used. For example if the user desires to change the crew size for a particular task, the factor would have to be changed in the particular unscheduled maintenance network at the await node and the free node. The variables described above can be changed by a user with a limited knowledge of SLAM. However, for any other changes, the user should have a working knowledge of SLAM to preclude inadvertent changes to the process being simulated.

<u>Slam Code</u>

```
GEN,MAKPINAR,F16MODEL,8/1/86,,N,N,,,,72;
LIMITS,24,98,750;
INTLC,XX(1)= 0.0;            NUMBER OF SORTIES FLOWN
INTLC,XX(2)= 1.0;            RELIABILITY FACTOR
INTLC,XX(3)= 1.0;            MAINTAINABILITY FACTOR
INTLC,XX(4)= 20.0;           DAILY SORTI RATE DESIRED
INTLC,XX(5)= 18.0;           R OF MISSION CAPABLE A/C
INTLC,XX(29)= 0.29;          VARIANCE OF MEAN
TIMST,XX(5),MSN CAP ACFT,18/0/1;
;
;    TIME UNIT IS HOUR
;
NETWORK;
      RESOURCE/A431F1(20),1;     CREW CHEIF FLIGHT LINE
      RESOURCE/A431R1(7),2;      TAC. A/C MAINT.
      RESOURCE/A427X4(2),3;      METAL PROCESSING
      RESOURCE/A423X0(9),4;      ELECT SHOP
      RESOURCE/A423X1(3),5;      ENVI. SHOP
      RESOURCE/A423X4(6),7;      PNEU SHOP
      RESOURCE/A423X3(10),9;      FUEL
      RESOURCE/A426X4(10),11;     JET ENGINE SHOP
      RESOURCE/A326X6(26),12;     TAC CONTROL
      RESOURCE/A427X5(2),13;     STRUCTURAL REPAIR
      RESOURCE/A427X3(2),14;     SUR.EQUIPMENT
      RESOURCE/A404X1(4),15;     SENSOR/PHOTO
      RESOURCE/A423X2(3),16;     EGRESS SHOP
      RESOURCE/A426T4(2),17;     ENGINE TEST CELL
      RESOURCE/A462X0(6),19;     MUNITION SHOP
      RESOURCE/A326X4(6),20;     AUTO TEST STATION
      RESOURCE/A326X7(8),21;     FCS TECH
      RESOURCE/A326X8(12),22;     COMM-NAV
      GATE/DAY,OPEN,23;
      GATE/STORM,OPEN,24;
;
;     MODEL SEGMENT 1  * SORTIE GENERATION *
;
      CREATE,0,,,18;        CREATES 18 OF 20 A/C
;
;       THE FOLLOWING STE OF ASSIGN STATEMENTS ASSIGN
;       MEAN FAILURE RATES TO THE DESIGNATED SYSTEM.
;
;       XX(6)=AIRFRAME-UM11
;       XX(7)=CREW STATION SYSTEM-UM12
;       XX(8)=LANDING GEAR-UM13
;       XX(9)=FLIGHT CONTROL SYSTEM-UM14
;       XX(10)=TURBOFAN POWER PLANT-UM23
;       XX(11)=AUXILARY POWER PLANT-UM24
;       XX(12)=ENVIROMENTAL CONTROL SYSTEM-UM41
;       XX(13)=ELECTRICAL POWER SYSTEM-UM42
;       XX(14)=LIGHTING SYSTEM-UM44
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;        XX(15)=HYDROLIC AND PNEUMATIC SYSTEM-UM45
;        XX(16)=FUEL SYSTEM-UM46
;        XX(17)=OXYGEN SYSTEM-UM47
;        XX(18)=MISCELLANEOUS SYSTEM-UM49
;        XX(19)=FLIGHT INSTRUMENT-UM51
;        XX(20)=MALFACTION ANAL. AND RECORDING EQUIP.-UM55
;        XX(21)=VHF COMMUNICATION-UM62
;        XX(22)=UHF COMMUNICATION-UM63
;        XX(23)=INTERFONE SYSTEM-UM64
;        XX(24)=IFF SYSTEM-UM65
;        XX(25)=RADIO NAVIGATION-UM71
;        XX(26)=FIRE CONTROL SYSTEM-UM74
;        XX(27)=WEAPONS DELIVERY-UM75
;        XX(28)=PENETRATION AIDS AND ECM-UM76
;
;

        ASSIGN,XX(6)=8.57*XX(2),
               XX(7)=39.6*XX(2),
               XX(8)=9.95*XX(2),
               XX(9)=17.3*XX(2),
               XX(10)=26.1*XX(2),
               XX(11)=20.0*XX(2);
        ASSIGN,XX(12)=49.9*XX(2),
               XX(13)=43.7*XX(2),
               XX(14)=22.6*XX(2),
               XX(15)=67.1*XX(2),
               XX(16)=21.2*XX(2),
               XX(17)=62.2*XX(2);
        ASSIGN,XX(18)=804.7*XX(2),
               XX(19)=61.2*XX(2),
               XX(20)=433.3*XX(2),
               XX(21)=52.5*XX(2),
               XX(22)=69.0*XX(2),
               XX(23)=433.3*XX(2);
        ASSIGN,XX(24)=67.8*XX(2),
               XX(25)=229.0*XX(2),
               XX(26)=13.3*XX(2),
               XX(27)=25.2*XX(2),
               XX(28)=30.1*XX(2);
;
;        THE FOLLOWING STATEMENTS ASSIGN THE FAILURE
;        RATES AS ATRIBUTES OF THE ENTITY.
;
       ASSIGN,ATRIB(1)=EXPON(XX(6),1),
              ATRIB(2)=EXPON(XX(7),1),
              ATRIB(3)=EXPON(XX(8),1),
              ATRIB(4)=EXPON(XX(9),1),
              ATRIB(5)=EXPON(XX(10),1),
              ATRIB(6)=EXPON(XX(11),1);
       ASSIGN,ATRIB(7)=EXPON(XX(12),1),
              ATRIB(8)=EXPON(XX(13),1),
              ATRIB(9)=EXPON(XX(14),1),
              ATRIB(10)=EXPON(XX(15),1),
```

```
        ATRIB(11)=EXPON(XX(16),1),
        ATRIB(12)=EXPON(XX(17),1);
ASSIGN, ATRIB(13)=EXPON(XX(18),1),
        ATRIB(14)=EXPON(XX(19),1),
        ATRIB(15)=EXPON(XX(20),1),
        ATRIB(16)=EXPON(XX(21),1),
        ATRIB(17)=EXPON(XX(22),1),
        ATRIB(18)=EXPON(XX(23),1);
ASSIGN, ATRIB(19)=EXPON(XX(24),1),
        ATRIB(20)=EXPON(XX(25),1),
        ATRIB(21)=EXPON(XX(26),1),
        ATRIB(22)=EXPON(XX(27),1),
        ATRIB(23)=EXPON(XX(28),1);
ASSIGN, ATRIB(24)= UNFRM(80,150,1),
        ATRIB(25)= UNFRM(240,300,1),
        ATRIB(26)= UNFRM(340,450,1),
        ATRIB(27)= UNFRM(490,600,1);
;
;  THE FOLLOWING STATEMENTS ASSIGN THE MEAN
;  AND VARIANCE TO THE REPAIR TIMES FOR THE
;  UNSCHEDULED MAINTENANCE.
;
ASSIGN, XX(30)=2.257*XX(3),ATRIB(30)=XX(30)*XX(29),
        XX(31)=4.420*XX(3),ATRIB(31)=XX(31)*XX(29),
        XX(32)=10.085*XX(3),ATRIB(32)=XX(32)*XX(29);
ASSIGN, XX(33)=3.211*XX(3),ATRIB(33)=XX(33)*XX(29),
        XX(34)=3.243*XX(3),ATRIB(34)=XX(34)*XX(29),
        XX(35)=3.260*XX(3),ATRIB(35)=XX(35)*XX(29);
ASSIGN, XX(36)=2.972*XX(3),ATRIB(36)=XX(36)*XX(29),
        XX(37)=3.289*XX(3),ATRIB(37)=XX(37)*XX(29),
        XX(38)=0.587*XX(3),ATRIB(38)=XX(38)*XX(29);
ASSIGN, XX(39)=5.584*XX(3),ATRIB(39)=XX(39)*XX(29),
        XX(40)=6.840*XX(3),ATRIB(40)=XX(40)*XX(29),
        XX(41)=6.200*XX(3),ATRIB(41)=XX(41)*XX(29);
ASSIGN, XX(42)=12.450*XX(3),ATRIB(42)=XX(42)*XX(29),
        XX(43)=12.900*XX(3),ATRIB(43)=XX(43)*XX(29),
        XX(44)=6.174*XX(3),ATRIB(44)=XX(44)*XX(29);
ASSIGN, XX(45)=4.152*XX(3),ATRIB(45)=XX(45)*XX(29),
        XX(46)=7.420*XX(3),ATRIB(46)=XX(46)*XX(29);
ASSIGN, XX(47)=2.279*XX(3),ATRIB(47)=XX(47)*XX(29),
        XX(48)=4.839*XX(3),ATRIB(48)=XX(48)*XX(29);
ASSIGN, XX(49)=2.452*XX(3),ATRIB(49)=XX(49)*XX(29),
        XX(50)=3.882*XX(3),ATRIB(50)=XX(50)*XX(29),
        XX(51)=5.120*XX(3),ATRIB(51)=XX(51)*XX(29);
ASSIGN, XX(52)=1.858*XX(3),ATRIB(52)=XX(52)*XX(29),
        XX(53)=1.818*XX(3),ATRIB(53)=XX(53)*XX(29),
        XX(54)=6.246*XX(3),ATRIB(54)=XX(54)*XX(29);
ASSIGN, XX(55)=2.270*XX(3),ATRIB(55)=XX(55)*XX(29),
        XX(56)=4.087*XX(3),ATRIB(56)=XX(56)*XX(29),
        XX(57)=7.858*XX(3),ATRIB(57)=XX(57)*XX(29);
ASSIGN, XX(58)=4.145*XX(3),ATRIB(58)=XX(58)*XX(29),
        XX(59)=5.004*XX(3),ATRIB(59)=XX(59)*XX(29),
        XX(60)=6.251*XX(3),ATRIB(60)=XX(60)*XX(29);
```

```
        ASSIGN,XX(61)=2.067*XX(3),ATRIB(61)=XX(61)*XX(29),
               XX(62)=1.152*XX(3),ATRIB(62)=XX(62)*XX(29);
        ASSIGN,XX(63)=2.150*XX(3),ATRIB(63)=XX(63)*XX(29),
               XX(64)=7.000*XX(3),ATRIB(64)=XX(64)*XX(29);
        ASSIGN,XX(65)=2.985*XX(3),ATRIB(65)=XX(65)*XX(29),
               XX(66)=3.310*XX(3),ATRIB(66)=XX(66)*XX(29),
               XX(67)=6.608*XX(3),ATRIB(67)=XX(67)*XX(29);
        ASSIGN,XX(68)=2.372*XX(3),ATRIB(68)=XX(68)*XX(29),
               XX(69)=1.707*XX(3),ATRIB(69)=XX(69)*XX(29);
        ASSIGN,XX(70)=2.182*XX(3),ATRIB(70)=XX(70)*XX(29),
               XX(71)=2.860*XX(3),ATRIB(71)=XX(71)*XX(29),
               XX(72)=7.562*XX(3),ATRIB(72)=XX(72)*XX(29);
        ASSIGN,XX(73)=1.924*XX(3),ATRIB(73)=XX(73)*XX(29),
               XX(74)=1.948*XX(3),ATRIB(74)=XX(74)*XX(29),
               XX(75)=6.192*XX(3),ATRIB(75)=XX(75)*XX(29);
        ASSIGN,XX(76)=2.819*XX(3),ATRIB(76)=XX(76)*XX(29),
               XX(77)=3.452*XX(3),ATRIB(77)=XX(77)*XX(29);
        ASSIGN,XX(78)=1.940*XX(3),ATRIB(78)=XX(78)*XX(29),
               XX(79)=2.630*XX(3),ATRIB(79)=XX(79)*XX(29);
        ASSIGN,XX(80)=1.960*XX(3),ATRIB(80)=XX(80)*XX(29),
               XX(81)=2.678*XX(3),ATRIB(81)=XX(81)*XX(29);
        ASSIGN,XX(82)=2.296*XX(3),ATRIB(82)=XX(82)*XX(29),
               XX(83)=2.992*XX(3),ATRIB(83)=XX(83)*XX(29),
               XX(84)=8.178*XX(3),ATRIB(84)=XX(84)*XX(29);
        ASSIGN,XX(85)=3.251*XX(3),ATRIB(85)=XX(85)*XX(29),
               XX(86)=2.855*XX(3),ATRIB(86)=XX(86)*XX(29),
               XX(87)=6.120*XX(3),ATRIB(87)=XX(87)*XX(29);
        ASSIGN,XX(88)=3.225*XX(3),ATRIB(88)=XX(88)*XX(29),
               XX(89)=3.702*XX(3),ATRIB(89)=XX(89)*XX(29),
               XX(90)=8.160*XX(3),ATRIB(90)=XX(90)*XX(29);
        ASSIGN,ATRIB(91)=0,ATRIB(92)=0;
;
;       FLIGHT LINE NETWORK
;
PRE     AWAIT(1),A431F1/4;                WAIT FOR CREW CHEIF
        ACT/1,RLOGN(1.2,.30,2);           PREFLIGHT CHECK
        FREE,A431F1/4;
        GOON,1;
        ACT,,ATRIB(92).EQ.1,G1;           CHECK TO SEE IF RETURNING
;                                         FROM PHASE
        ACT,,ATRIB(92).EQ.0;              IF NOT RETURNING FROM PHASE
;                                         COLLECT TURN TIME
        COLCT,INT(91),TURN TIME;
G1      ASSIGN,ATRIB(92)=0;
RTRN    AWAIT(23),DAY;                    WAIT FOR DAY LIGHT
        AWAIT(24),STORM;                  WAIT FOR CLEAR WEATHER
        GOON,1;
        ACT,,NNGAT(DAY).EQ.1,RTRN;        IF WEATHER CLEARS BUT
;                                         IT IS NIGHT,RETURNS TO WAIT
        ACT,,NNGAT(DAY).EQ.0;             IF IT IS DAYLIGHT AND CLEAR
;                                         WEATHER A/C FLYES
SORT    ASSIGN,XX(1)=XX(1)+1.0,2;         INCREASE THE R OF DAILY
;                                         SORTIES FLOWN
```

```
      ACT,0.5,,FLY;                      DELAY FOR VARIOUS PRE-LAUNCH
;                                        TASKS
      ACT,,XX(1).GE.XX(4),RSET;          IF DAILY SORTIE RATE HAS
;                                        BEEN MET CLOSE THE DAY GATE
      ACT;
      TERM;
RSET  CLOSE,DAY;
      TERM;
FLY   ASSIGN,XX(96)=RNORM(2,.5,2);       ASSIGN SORTIE LENGTH
      ACT/2,XX(96);                      FLY SORTIE
      ASSIGN,ATRIB(91)=TNOW;             INITIATE TURN TIME CLOCK
;
;     THE FOLLOWING STATEMENTS DECREMENT THE
;     FAILURE CLOCKS FOR EACH SYSTEM.
;
      ASSIGN,ATRIB(1)=ATRIB(1)-1,
             ATRIB(2)=ATRIB(2)-1,
             ATRIB(3)=ATRIB(3)-1,
             ATRIB(4)=ATRIB(4)-1,
             ATRIB(5)=ATRIB(5)-1,
             ATRIB(6)=ATRIB(6)-1;
      ASSIGN,ATRIB(7)=ATRIB(7)-1,
             ATRIB(8)=ATRIB(8)-1,
             ATRIB(9)=ATRIB(9)-1,
             ATRIB(10)=ATRIB(10)-1,
             ATRIB(11)=ATRIB(11)-1,
             ATRIB(12)=ATRIB(12)-1,
             ATRIB(13)=ATRIB(13)-1;
      ASSIGN,ATRIB(14)=ATRIB(14)-1,
             ATRIB(15)=ATRIB(15)-1,
             ATRIB(16)=ATRIB(16)-1,
             ATRIB(17)=ATRIB(17)-1,
             ATRIB(18)=ATRIB(18)-1,
             ATRIB(19)=ATRIB(19)-1,
             ATRIB(20)=ATRIB(20)-1;
      ASSIGN,ATRIB(21)=ATRIB(21)-1,
             ATRIB(22)=ATRIB(22)-1,
             ATRIB(23)=ATRIB(23)-1;
      ASSIGN,ATRIB(24)=ATRIB(24)-XX(72);
      ASSIGN,ATRIB(25)=ATRIB(25)-XX(72);
      ASSIGN,ATRIB(26)=ATRIB(26)-XX(72);
      ASSIGN,ATRIB(27)=ATRIB(27)-XX(72);

      GOON;
      ACT,.4;                            TAXI AND PARK TIME
      AWAIT(1),A431F1/4;                 WAIT FOR CREW CHEIFS
      ACT/4,RLOGN(.30,.10,2);            PERFORM POST-FLIGHT CHECK
      FREE,A431F1/4;
      ASSIGN,ATRIB(94)=TNOW,ATRIB(95)=TNOW;
;
;     THE FALLOWING ACTIVITIES CHECK THE FAILURE
;     CLOCKS FOR UNSHEDULED AND PHASE MAINTENANCE.
;
```

```
GN1    GOON,1;
       ACT/5,,ATRIB(1).LE.0,UM11;
       ACT/5,,ATRIB(2).LE.0,UM12;
       ACT/5,,ATRIB(3).LE.0,UM13;
       ACT/5,,ATRIB(4).LE.0,UM14;
       ACT/5,,ATRIB(5).LE.0,UM23;
       ACT/5,,ATRIB(6).LE.0,UM24;
       ACT/5,,ATRIB(7).LE.0,UM41;
       ACT/5,,ATRIB(8).LE.0,UM42;
       ACT/5,,ATRIB(9).LE.0,UM44;
       ACT/5,,ATRIB(10).LE.0,UM45;
       ACT/5,,ATRIB(11).LE.0,UM46;
       ACT/5,,ATRIB(12).LE.0,UM47;
       ACT/5,,ATRIB(13).LE.0,UM49;
       ACT/5,,ATRIB(14).LE.0,UM51;
       ACT/5,,ATRIB(15).LE.0,UM55;
       ACT/5,,ATRIB(16).LE.0,UM62;
       ACT/5,,ATRIB(17).LE.0,UM63;
       ACT/5,,ATRIB(18).LE.0,UM64;
       ACT/5,,ATRIB(19).LE.0,UM65;
       ACT/5,,ATRIB(20).LE.0,UM71;
       ACT/5,,ATRIB(21).LE.0,UM74;
       ACT/5,,ATRIB(22).LE.0,UM75;
       ACT/5,,ATRIB(23).LE.0,UM76;
       ACT/5,,ATRIB(24).LE.0,PH1;
       ACT/5,,ATRIB(25).LE.0,PH2;
       ACT/5,,ATRIB(26).LE.0,PH3;
       ACT/5,,ATRIB(27).LE.0,PH4;
       ACT;
COL1   COLCT,INT(94),MAINT TIME;         COLLECT TIME IN UNSCHEDULED
;                                        AND PHASE MAINTENANCE
       ACT,,,PRE;                        IF NO USM AND PHASE MAINT.
;                                        ENTITY SENT TO PRE FLIGHT
;
;
;      MODEL SEGMENT II  ** BAD WEATHER **
;
       CREATE;                  CREATES BAD WEATHER FOR EVERY
;                               18-30 HOURS
       ACT,UNFRM(18,30,2);
CLS    CLOSE,STORM;
       ACT/6,UNFRM(1,2.5,2);
       OPEN,STORM;
       ACT,UNFRM(18,30,2),,CLS;
;
;      MODEL SEGMENT III  ** DAY / NIGHT **
;
       CREATE;
BACK   OPEN,DAY;
       ACT,12;
       CLOSE,DAY;
       ACT,12,,BACK;
;
```

```
        CREATE,24,23;
        COLCT,XX(1),SORTIES,40/1/1;       COLLECT STATISTICS ON
;                                         DAILY FLOWN SORTIES
        ASSIGN,XX(4)=XX(4)-XX(1)+20.0;
        ASSIGN,XX(1)=0.0;                 RESET SORTIE COUNTER
        TERM;
;
;       MODEL SEGMENT IV ** SHIFT CHANGES **
;
         CREATE;
         ACT,8;
SHFT     ALTER,A431F1/0;
         ALTER,A431R1/0;
         ALTER,A427X3/0;
         ALTER,A423X0/0;
         ALTER,A423X1/0;
         ALTER,A423X4/0;
         ALTER,A423X3/0;
         ALTER,A426X4/0;
         ALTER,A326X6/0;
         ALTER,A427X5/0;
         ALTER,A427X4/0;
         ALTER,A404X1/0;
         ALTER,A423X2/0;
         ALTER,A426T4/0;
         ALTER,A462X0/0;
         ALTER,A326X4/0;
         ALTER,A326X7/0;
         ALTER,A326X8/0;
         ACT,8;
         ALTER,A431F1/-12;
         ALTER,A431R1/-7;
         ALTER,A427X3/-2;
         ALTER,A423X0/-9;
         ALTER,A423X1/-3;
         ALTER,A423X4/-6;
         ALTER,A423X3/-10;
         ALTER,A426X4/-10;
         ALTER,A326X6/-10;
         ALTER,A427X5/-2;
         ALTER,A427X4/-2;
         ALTER,A404X1/-4;
         ALTER,A423X2/-3;
         ALTER,A426T4/-2;
         ALTER,A462X0/-6;
         ALTER,A326X4/-6;
         ALTER,A326X7/-4;
         ALTER,A326X8/-6;
         ACT,8;
         ALTER,A431F1/12;
         ALTER,A431R1/7;
         ALTER,A427X3/2;
         ALTER,A423X0/9;
```

```
        ALTER,A423X1/3;
        ALTER,A423X4/6;
        ALTER,A423X3/10;
        ALTER,A426X4/10;
        ALTER,A326X6/10;
        ALTER,A427X5/2;
        ALTER,A427X4/2;
        ALTER,A404X1/4;
        ALTER,A423X2/3;
        ALTER,A426T4/2;
        ALTER,A462X0/6;
        ALTER,A326X4/6;
        ALTER,A326X7/4;
        ALTER,A326X8/6;
        ACT,8,,SHFT;
;
;
;  MODEL SEGMENT V  **UNSHEDULED MAINTENANCE**
;
UM11    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.10,RR11;    REMOVE AND REPLACE
        ACT,,.90;         ON A/C REPAIR
        GOON;
        ACT,,.38,A111;    TAC A/C MAINT
        ACT,,.40,A112;    FUEL
        ACT,,.08,A113;    STRUCTURAL REPAIR
        ACT,,.05,A114;    TAC CONTROL
        ACT,,.09;         COMM-NAV
        AWAIT(22),A326X8/1;
        ACT/13,RLOGN(XX(30),ATRIB(30),3);
        FREE,A326X8/1;
ASG1    ASSIGN,ATRIB(1)=EXPON(XX(6),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A111    AWAIT(2),A431R1/1;
        ACT/13,RLOGN(XX(30),ATRIB(30),3);
        FREE,A431R1/1;
        ACT,,,ASG1;
A112    AWAIT(9),A423X3/2;
        ACT/13,RLOGN(XX(30),ATRIB(30),3);
        FREE,A423X3/2;
        ACT,,,ASG1;
A113    AWAIT(13),A427X5/1;
        ACT/13,RLOGN(XX(30),ATRIB(30),3);
        FREE,A427X5/1;
        ACT,,,ASG1;
A114    AWAIT(12),A326X6/2;
        ACT/13,RLOGN(XX(30),ATRIB(30),3);
        FREE,A326X6/1;
        ACT,,,ASG1;
RR11    GOON;
        ACT,,.66,R111;    FUEL
        ACT,,.33,R112;    TAC A/C MAINT
```

```
        ACT,,.05,R113;    JET ENGINE
        ACT,,.06;         COMM-NAV
        AWAIT(22),A326X8/1;
        ACT/14,RLOGN(XX(31),ATRB(31),3);
        FREE,A326X8/1;
ASG2    ASSIGN,ATRIB(1)=EXPON(XX(6),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,.98,S111;    STRUCTURAL REPAIR
        ACT,,.02,S112;    PNEU SHOP
R111    AWAIT(9),A423X3/2;
        ACT/14,RLOGN(XX(31),ATRIB(31),3);
        FREE,A423X3/2;
        ACT,,,ASG2;
R112    AWAIT(2),A431R1/2;
        ACT/14,RLOGN(XX(31),ATRIB(31),3);
        FREE,A431R1/2;
        ACT,,,ASG2;
R113    AWAIT(11),A426X4/2;
        ACT/14,RLOGN(XX(31),ATRIB(31),3);
        FREE,A426X4/2;
        ACT,,,ASG2;
S111    AWAIT(13),A427X5/1;
        ACT/15,RLOGN(XX(32),ATRIB(32),3);
        FREE,A427X5/1;
        ACT,,,COL;
S112    AWAIT(7),A423X4/1;
        ACT/15,RLOGN(XX(32),ATRIB(32),3);
        FREE,A423X4/1;
        ACT,,,COL;
;
;
UM12    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.14,RR12;    REMOVE AND REPLACE
        ACT,,.86,;        ON A/C REPAIR
        GOON;
        ACT,,.84,A121;    EGRESS SHOP
        ACT,,.09,A122;    TAC A/C MAINT
        ACT,,.07;         COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/16,RLOGN(XX(33),ATRIB(33),3);
        FREE,A326X8/2;
ASG3    ASSIGN,ATRIB(2)=EXPON(XX(7),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A121    AWAIT(16),A423X2/3;
        ACT/16,RLOGN(XX(33),ATRIB(33),3);
        FREE,A423X2/3;
        ACT,,,ASG3;
A122    AWAIT(2),A431R1/1;
        ACT/16,RLOGN(XX(33),ATRIB(33),3);
        FREE,A431R1/1;
        ACT,,,ASG3;
RR12    GOON;
```

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        ACT,,.53,R121;     EGRESS SHOP
        ACT,,.32,R121;     TAC A/C MAINT
        ACT,,.09,R123;     JET ENGINE
        ACT,,.06;          TAC CONTROL
        AWAIT(12),A326X6/2;
        ACT/17,RLOGN(XX(34),ATRIB(34),3);
        FREE,A326X6/2;
ASG4    ASSIGN,ATRIB(2)=EXPON(XX(7),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,.49,S121;     STRUCTURAL REPAIR
        ACT,,.25,S122;     PNEU SHOP
        ACT,,.18,S123;     SUR. EQUIPMENT
        ACT,,.08,S124;      ELECT.
R121    AWAIT(16),A423X2/3;
        ACT/17,RLOGN(XX(34),ATRIB(34),3);
        FREE,A423X2/3;
        ACT,,,ASG4;
R122    AWAIT(2),A431R1/1;
        ACT/17,RLOGN(XX(34),ATRIB(34),3);
        FREE,A431R1/1;
        ACT,,,ASG4;
R123    AWAIT(11),A426X4/3;
        ACT/17,RLOGN(XX(34),ATRIB(34),3);
        FREE,A426X4/3;
        ACT,,,ASG4;
S121    AWAIT(13),A427X5/1;
        ACT/18,RLOGN(XX(35),ATRIB(35),3);
        FREE,A427X5/1;
        ACT,,,COL;
S122    AWAIT(7),A423X4/4;
        ACT/18,RLOGN(XX(35),ATRIB(35),3);
        FREE,A423X4/4;
        ACT,,,COL;
S123    AWAIT(14),A427X3/2;
        ACT/18,RLOGN(XX(35),ATRIB(35),3);
        FREE,A427X3/2;
        ACT,,,COL;
S124    AWAIT(4),A423X0/1;
        ACT/18,RLOGN(XX(35),ATRIB(35),3);
        FREE,A423X0/1;
        ACT,,,COL;
;
;
UM13    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.42,RR13;     REMOVE AND REPLACE
        ACT,,.58;          REPAIR ON A/C
        GOON;
        ACT,,.30,A131;     TAC CONTROL
        ACT,,.20,A132;     COMM-NAV
        ACT,,.21,A133;     JET ENGINE
        ACT,,.11,A134;     TAC A/C MAINT
        ACT,,.06,A135;     FCS
```

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         ACT,,.07,A136;      ELECT. SHOP
         ACT,,.05;           PNEU SHOP
         AWAIT(7),A423X4/2;
         ACT/19,RLOGN(XX(36),ATRIB(36),3);
         FREE,A423X4/2;
ASG5     ASSIGN,ATRIB(3)=EXPON(XX(8),1),XX(5)=XX(5)+1;
         ACT,,,GN1;
A131     AWAIT(12),A326X6/2;
         ACT/19,RLOGN(XX(36),ATRIB(36),3);
         FREE,A326X6/2;
         ACT,,,ASG5;
A132     AWAIT(22),A326X8/2;
         ACT/19,RLOGN(XX(36),ATRIB(36),3);
         FREE,A326X8/2;
         ACT,,,ASG5;
A133     AWAIT(11),A426X4/3;
         ACT/19,RLOGN(XX(36),ATRIB(36),3);
         FREE,A426X4/3;
         ACT,,,ASG5;
A134     AWAIT(2),A431R1/2;
         ACT/19,RLOGN(XX(36),ATRIB(36),3);
         FREE,A431R1/2;
         ACT,,,ASG5;
A135     AWAIT(21),A326X7/2;
         ACT/19,RLOGN(XX(36),ATRIB(36),3);
         FREE,A326X7/2;
         ACT,,,ASG5;
A136     AWAIT(4),A423X0/2;
         ACT/19,RLOGN(XX(36,ATRIB(36),3);
         FREE,A423X0/2;
         ACT,,,ASG5;
RR13     GOON;
         ACT,,.10,R131;      PNEU SHOP
         ACT,,.13,R132;      FCS
         ACT,,.16,R133;      COMM-NAV
         ACT,,.47,R134;      TAC A/C MAINT.
         ACT,,.14;           TAC CONTROL
         AWAIT(12),A326X6/3;
         ACT/20,RLOGN(XX(37),ATRIB(37),3);
         FREE,A326X6/3;
ASG6     ASSIGN,ATRIB(3)=EXPON(XX(8),1),XX(5)=XX(5)+1;
         ACT,,,GN1;
         ACT,,.89,S131;      PNEU SHOP
         ACT,,.11,S132;      TAC A/C MAINT.
R131     AWAIT(7),A423X4/2;
         ACT/20,RLOGN(XX(37),ATRIB(37),3);
         FREE,A423X4/2;
         ACT,,,ASG6;
R132     AWAIT(21),A326X7/2;
         ACT/20,RLOGN(XX(37),ATRIB(37),3);
         FREE,A326X7/2;
         ACT,,,ASG6;
R133     AWAIT(22),A326X8/2;
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        ACT/20,RLOGN(XX(37),ATRIB(37),3);
        FREE,A326X8/2;
        ACT,,,ASG6;
R134    AWAIT(2),A431R1/2;
        ACT/20,RLOGN(XX(37),ATRIB(37),3);
        FREE,A431R1/2;
        ACT,,,ASG6;
S131    AWAIT(7),A423X4/3;
        ACT/21,RLOGN(XX(38),ATRIB(38),3);
        FREE,A423X4/3;
        ACT,,,COL;
S132    AWAIT(2),A431R1/3;
        ACT/21,RLOGN(XX(38),ATRIB(38),3);
        FREE,A431R1/3;
        ACT,,,COL;
;
;
UM14    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.28,RR14;     REMOVE AND REPLACE
        ACT,,.72;          ON A/C REPAIR
        GOON;
        ACT,,.45,A141;     TAC CONTROL
        ACT,,.32,A142;     COMM-NAV
        ACT,,.23;          FCS
        AWAIT(21),A326X7/3;
        ACT/22,RLOGN(XX(39),ATRIB(39),3);
        FREE,A326X7/3;
ASG7    ASSIGN,ATRIB(4)=EXPON(XX(9),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A141    AWAIT(12),A326X6/4;
        ACT/22,RLOGN(XX(39),ATRIB(39),3);
        FREE,A326X6/4;
        ACT,,,ASG7;
A142    AWAIT(22),A326X8/3;
        ACT/22,RLOGN(XX(39),ATRIB(39),3);
        FREE,A326X8/3;
        ACT,,,ASG7,
RR14    GOON;
        ACT,,.23,R141;     TAC CONTROL
        ACT,,.20,R142;     FCS
        ACT,,.40,R143;     COMM-NAV
        ACT,,.10,R144;     JET ENGINE
        ACT,,.07;          TAC A/C MAINT.
        AWAIT(2),A431R1/2;
        ACT/23,RLOGN(XX(40),ATRIB(40),3);
        FREE,A431R1/2;
ASG8    ASSIGN,ATRIB(4)=EXPON(XX(9),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,.87,S141;     AUTO TEST
        ACT,,.13,S142;     PNEU SHOP
R141    AWAIT(12),A326X6/4;
        ACT/23,RLOGN(XX(40),ATRIB(40),3);
```

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        FREE,A326X6/4;
        ACT,,,ASG8;
R142    AWAIT(21),A326X7/3;
        ACT/23,RLOGN(XX(40),ATRIB(40),3);
        FREE,A326X7/3;
        ACT,,,ASG8;
R143    AWAIT(22),A326X8/3;
        ACT/23,RLOGN(XX(40),ATRIB(40),3);
        FREE,A326X8/3;
        ACT,,,ASG8;
R144    AWAIT(11),A426X4/3;
        ACT/23,RLOGN(XX(40,ATRIB(40),3);
        FREE,A426X4/3;
        ACT,,,ASG8;
S141    AWAIT(20),A326X4/1;
        ACT/24,RLOGN(XX(41),ATRIB(41),3);
        FREE,A326X4/1;
        ACT,,,COL;
S142    AWAIT(7) A423X4/3;
        ACT/24,RLOGN(XX(41),ATRIB(41),3);
        FREE,A423X4/3;
        ACT,,,COL;

;
;
UM23    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.35,RR23;     REMOVE AND REPLACE
        ACT,,.65;          ON A/C REPAIR
        GOON;
        ACT,,.18,A231;     TAC CONTROL
        ACT,,.14,A232;     FCS
        ACT,,.22,A233;     COMM-NAV
        ACT,,.46;          JET ENGINE
        AWAIT(11),A426X4/4;
        ACT/25,RLOGN(XX(42),ATRIB(42),3);
        FREE,A426X4/4;
ASG9    ASSIGN,ATRIB(5)=EXPON(XX(10),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A231    AWAIT(12),A326X6/4;
        ACT/25,RLOGN(XX(42),ATRIB(42),3);
        FREE,A326X6/4;
        ACT,,,ASG9;
A232    AWAIT(21),A326X7/4;
        ACT/25,RLOGN(XX(42),ATRIB(42),3);
        FREE,A326X7/4;
        ACT,,,ASG9;
A233    AWAIT(22),A326X8/4;
        ACT/25,RLOGN(XX(42),ATRIB(42),3);
        FREE,A326X8/4;
        ACT,,,ASG9;
RR23    GOON;
        ACT,,.26,R231;     TAC CONTROL
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```
        ACT,,.13,R232;    FCS
        ACT,,.20,R233;    COMM-NAV
        ACT,,.34,R234;    JET ENGINE
        ACT,,.07;         TAC A/C MAINT.
        AWAIT(2),A431R1/4;
        ACT/26,RLOGN(XX(43),ATRIB(43),3);
        FREE,A431R1/4;
AS10    ASSIGN,ATRIB(5)=EXPON(XX(10),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,.35,S231;    STRUCTURAL REPAIR
        ACT,,.38,S232;    METAL PROCESSING
        ACT,,.27,S233;    AUTO TEST STATION
R231    AWAIT(12),A326X6/4;
        ACT/26,RLOGN(XX(43),ATRIB(43),3);
        FREE,A326X6/4;
        ACT,,,AS10;
R232    AWAIT(21),A326X7/4;
        ACT/26,RLOGN(XX(43),ATRIB(43),3);
        FREE,A326X7/4;
        ACT,,,AS10;
R233    AWAIT(22),A326X8/4;
        ACT/26,RLOGN(XX(43),ATRIB(43),3);
        FREE,A326X8/4;
        ACT,,,AS10;
R234    AWAIT(11),A426X4/4;
        ACT/26,RLOGN(XX(43),ATRIB(43),3);
        FREE,A426X4/4;
        ACT,,,AS10;
S231    AWAIT(13),A427X5/1;
        ACT/27,RLOGN(XX(44),ATRIB(44),3);
        FREE,A427X5/1;
        ACT,,,COL;
S232    AWAIT(3),A427X4/2;
        ACT/27,RLOGN(XX(44),ATRIB(44),3);
        FREE,A427X4/2;
        ACT,,,COL;
S233    AWAIT(20),A326X4/2;
        ACT/27,RLOGN(XX(44),ATRIB(44),3);
        FREE,A326X4/2;
        ACT,,,COL;
;
;
UM24    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.42,RR24;    REMOVE AND REPLACE
        ACT,,.58;         ON A/C REPAIR
        GOON;
        ACT,,.20,A241;    TAC CONTROL
        ACT,,.14,A242;    COMM-NAV
        ACT,,.33,A243;    FUEL
        ACT,,.24,A244;    JET ENGINE
        ACT,,.09;         ELECT. SHOP
        AWAIT(4),A423X0/2;
```

```
        ACT/28,RLOGN(XX(45),ATRIB(45),3);
        FREE,A423X0/2;
AS11    ASSIGN,ATRIB(6)=EXPON(XX(11),1);
        ASSIGN,XX(5)=XX(5)+1;
        ACT,,,GN1;
A241    AWAIT(12),A326X6/3;
        ACT/28,RLOGN(XX(45),ATRIB(45),3);
        FREE,A326X6/3;
        ACT,,,AS11;
A242    AWAIT(22),A326X8/2;
        ACT/28,RLOGN(XX(45),ATRIB(45),3);
        FREE,A326X8/2;
        ACT,,,AS11;
A243    AWAIT(9),A423X3/3;
        ACT/28,RLOGN(XX(45),ATRIB(45),3);
        FREE,A423X3/3;
        ACT,,,AS11;
A244    AWAIT(11),A426X4/3;
        ACT/28,RLOGN(XX(45),ATRIB(45),3);
        FREE,A426X4/3;
        ACT,,,AS11;
RR24    GOON;
        ACT,,.27,R241;     TAC CONTROL
        ACT,,.12,R242;     FCS
        ACT,,.21,R243;     COMM-NAV
        ACT,,.17,R244;     FUEL
        ACT,,.23;          JET ENGINE
        AWAIT(11),A426X4/3;
        ACT/29,RLOGN(XX(46),ATRIB(46),3);
        FREE,A426X4/3
AS12    ASSIGN,ATRIB(6)=EXPON(XX(11),1);
        ASSIGN,XX(5)=XX(5)+1;
        ACT,,,GN1;
R241    AWAIT(12),A326X6/3;
        ACT/29,RLOGN(XX(46),ATRIB(46),3);
        FREE,A326X6/3;
        ACT,,,AS12;
R242    AWAIT(21),A326X7/3;
        ACT/29,RLOGN(XX(46),ATRIB(46),3);
        FREE,A326X7/3;
        ACT,,,AS12;
R243    AWAIT(22),A326X8/3;
        ACT/29,RLOGN(XX(46),ATRIB(46),3);
        FREE,A326X8/3;
        ACT,,,AS12;
R244    AWAIT(9),A423X3/3;
        ACT/29,RLOGN(XX(46),ATRIB(46),3);
        FREE,A423X3/3;
        ACT,,,AS12;
;
```

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        UM41    ASSIGN,XX(5)=XX(5)-1;
                GOON;
                ACT,,.37,RR41;     REMOVE AND REPLACE
                ACT,,.63;          ON A/C REPAIR
                GOON;
                ACT,,.18,A411;     FCS
                ACT,,.27,A412;     COMM-NAV
                ACT,,.22,A413;     TAC CONTROL
                ACT,,.16,A414;     ELECT.SHOP
                ACT,,.17;          JET ENGINE
                AWAIT(11),A426X4/1;
                ACT/30,RLOGN(XX(47),ATRIB(47),3);
                FREE,A426X4/1;
        AS13    ASSIGN,ATRIB(7)=EXPON(XX(12),1),XX(5)=XX(5)+1;
                ACT,,,GN1;
        A411    AWAIT(21),A326X7/2;
                ACT/30,RLOGN(XX(47),ATRIB(47),3);
                FREE,A326X7/2;
                ACT,,,AS13;
        A412    AWAIT(22),A326X8/2;
                ACT/30,RLOGN(XX(47),ATRIB(47),3);
                FREE,A326X8/2;
                ACT,,,AS13;
        A413    AWAIT(12),A326X6/2;
                ACT/30,RLOGN(XX(47),ATRIB(47),3);
                FREE,A326X6/2;
                ACT,,,AS13;
        A414    AWAIT(4),A423X0/2;
                ACT/30,RLOGN(XX(47),ATRIB(47),3);
                FREE,A423X0/2;
                ACT,,,AS13;
        RR41    GOON;
                ACT,,.05,R411;     ENVI.SHOP
                ACT,,.22,R413;     FCS
                ACT,,.38,R413;     COMM-NAV
                ACT,,.20,R414;     ELECT.SHOP
                ACT,,.15;          JET ENGINE
                AWAIT(11),A426X4/2;
                ACT/31,RLOGN(XX(48),ATRIB(48),3);
                FREE,A426X4/2;
        AS14    ASSIGN,ATRIB(7)=EXPON(XX(12),1),XX(5)=XX(5)+1;
                ACT,,,GN1;
        R411    AWAIT(5),A423X1/2;
                ACT/31,RLOGN(XX(48),ATRIB(48),3);
                FREE,A423X1/2;
                ACT,,,AS14;
        R412    AWAIT(21),A326X7/2;
                ACT/31,RLOGN(XX(48),ATRIB(48),3);
                FREE,A326X7/2;
                ACT,,,AS14;
        R413    AWAIT(22),A326X8/2;
```

```
        ACT/31,RLOGN(XX(48),ATRIB(48),3);
        FREE,A326X8/2;
        ACT,,,AS14;
R414    AWAIT(4),A423X0/3;
        ACT/31,RLOGN(XX(48),ATRIB(48),3);
        FREE,A423X0/3;
        ACT,,,AS14;
;
;
UM42    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.38,RR42;     REMOVE AND REPLACE
        ACT,,.62;          ON A/C REPAIR
        GOON;
        ACT,,.30,A421;     TAC CONTROL
        ACT,,.29,A422;     COMM-NAV
        ACT,,.10,A423;     ELECT.SHOP
        ACT,,.17,A424;     JET ENGINE
        ACT,,.14;          TAC A/C MAINT
        AWAIT(2),A431R1/1;
        ACT/32,RLOGN(XX(49),ATRIB(49),3);
        FREE,A431R1/1;
AS15    ASSIGN,ATRIB(8)=EXPON(XX(13),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A421    AWAIT(12),A326X6/3;
        ACT/32,RLOGN(XX(49),ATRIB(49),3);
        FREE,A326X6/3;
        ACT,,,AS15;
A422    AWAIT(22),A326X8/3;
        ACT/32,RLOGN(XX(49),ATRIB(49),3);
        FREE,A326X8/3;
        ACT,,,AS15;
A423    AWAIT(4),A423X0/2;
        ACT/32,RLOGN(XX(49),ATRIB(49),3);
        FREE,A423X0/2;
        ACT,,,AS15;
A424    AWAIT(11),A426X4/3;
        ACT/32,RLOGN(XX(49),ATRIB(49),3);
        FREE,A426X4/3;
        ACT,,,AS15;
RR42    GOON;
        ACT,,.26,R421;     TAC CONTROL
        ACT,,.19,R422;     FCS
        ACT,,.26,R423;     COMM-NAV
        ACT,,.18,R424;     JET ENGINE
        ACT,,.11;          TAC A/C MAINT.
        AWAIT(2),A431R1/2;
        ACT/33,RLOGN(XX(50),ATRIB(50),3);
        FREE,A431R1/2;
AS16    ASSIGN,ATRIB(8)=EXPON(XX(13),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,.96,S421;     ELECT.SHOP
        ACT,,.04,S422;     STRUCTURAL REPAIR
```

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R421    AWAIT(12),A326X6/3;
        ACT/33,RLOGN(XX(50),ATRIB(50),3);
        FREE,A326X6/3;
        ACT,,,AS16;
R422    AWAIT(21),A326X7/2;
        ACT/33,RLOGN(XX(50),ATRIB(50),3);
        FREE,A326X7/2;
        ACT,,,AS16;
R423    AWAIT(22),A326X8/2;
        ACT/33,RLOGN(XX(50),ATRIB(50),3);
        FREE,A326X8/2;
        ACT,,,AS16;
R424    AWAIT(11),A426X4/2;
        ACT/33,RLOGN(XX(50),ATRIB(50),3);
        FREE,A426X4/2;
        ACT,,,AS16;
S421    AWAIT(4),A423X0/3;
        ACT/34,RLOGN(51),ATRIB(51),3);
        FREE,A423X0/3;
        ACT,,,COL;
S422    AWAIT(13),A427X5/1;
        ACT/34,RLOGN(XX(51,ATRIB(51),3);
        FREE,A427X5/1;
        ACT,,,COL;
;
;
UM44    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.52,RR44;     REMOVE AND REPLACE
        ACT,,.48;          ON A/C REPAIR
        GOON;
        ACT,,.33,A441;     TAC CONTROL
        ACT,,.29,A442;     COMM-NAV
        ACT,,.13,A443;     TAC A/C MAINT.
        ACT,,.17,A444;     ELECT.SHOP
        ACT,,.08;          JET ENGINE
        AWAIT(11),A426X4/2;
        ACT/35,RLOGN(XX(52),ATRIB(52),3);
        FREE,A426X4/2;
AS17    ASSIGN,ATRIB(9)=EXPON(XX(14),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A441    AWAIT(12),A326X6/3;
        ACT/35,RLOGN(XX(52),ATRIB(52),3);
        FREE,A326X6/3;
        ACT,,,AS17;
A442    AWAIT(22),A326X8/2;
        ACT/35,RLOGN(XX(52),ATRIB(52),3);
        FREE,A326X8/2;
        ACT,,,AS17;
A443    AWAIT(2),A431R1/1;
        ACT/35,RLOGN(XX(52),ATRIB(52.,3);
        FREE,A431R1/1;
        ACT,,.AS17;
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A444    AWAIT(4),A423X0/2;
        ACT/35,RLOGN(XX(52),ATRIB(52),3);
        FREE,A423X0/2;
        ACT,,,AS17;
RR44    GOON;
        ACT,,.42,R441;    TAC A/C MAINT
        ACT,,.13,R442;    TAC CONTROL
        ACT,,.14,R443;    FCS
        ACT,,.13,R444;    COMM-NAV
        ACT,,.18;         JET ENGINE
        AWAIT(11),A426X4/3;
        ACT/36,RLOGN(XX(53),ATRIB(53),3);
        FREE,A426X4/3;
AS18    ASSIGN,ATRIB(9)=EXPON(XX(14),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,,S441;   ELECT.SHOP
        ACT,,,S442;   ENGINE TEST CELL
R441    AWAIT(2),A431R1/2;
        ACT/36,RLOGN(XX(53),ATRIB(53),3);
        FREE,A431R1/2;
        ACT,,,AS18;
R442    AWAIT(12),A326X6/3;
        ACT/36,RLOGN(XX(53),ATRIB(53),3);
        FREE,A326X6/3;
        ACT,,,AS18;
R443    AWAIT(21),A326X7/2;
        ACT/36,RLOGN(XX(53),ATRIB(53),3);
        FREE,A326X7/2;
        ACT,,,AS18;
R444    AWAIT(22),A326X8/2;
        ACT/36,RLOGN(XX(53),ATRIB(53),3);
        FREE,A326X8/2;
        ACT,,,AS18;
S441    AWAIT(4),A423X0/3;
        ACT/37,RLOGN(XX(54),ATRIB(54),3);
        FREE,A423X0/3;
        ACT,,,COL;
S442    AWAIT(17),A426T4/2;
        ACT/37,RLOGN(XX(54),ATRIB(54),3);
        FREE,A426T4/2;
        ACT,,,COL;
;
;
UM45    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.36,RR45;    REMOVE AND REPLACE
        ACT,,.64;         ON A/C REPAIR
        GOON;
        ACT,,.34,A451;    TAC CONTROL
        ACT,,.14,A452;    COMM-NAV
        ACT,,.12,A453;    ELECT.SHOP
        ACT,,.24,A454;    JET ENGINE
        ACT,,.16;         TAC A/C MAINT.
```

```
        AWAIT(2),A431R1/2;
        ACT/38,RLOGN(XX(55),ATRIB(55),3);
        FREE,A431R1/2;
AS19    ASSIGN,ATRIB(10)=EXPON(XX(15),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A451    AWAIT(12),A326X6/3;
        ACT/38,RLOGN(XX(55),ATRIB(55),3);
        FREE,A326X6/3;
        ACT,,,AS19;
A452    AWAIT(22),A326X8/2;
        ACT/38,RLOGN(XX(55),ATRIB(55),3);
        FREE,A326X8/2;
        ACT,,,AS19;
A453    AWAIT(4),A423X0/3;
        ACT/38,RLOGN(XX(55),ATRIB(55),3);
        FREE,A423X0/3;
        ACT,,,AS19;
A454    AWAIT(11),A426X4/3;
        ACT/38,RLOGN(XX(55),ATRIB(55),3);
        FREE,A426X4/3;
        ACT,,,AS19;
RR45    GOON;
        ACT,,.28,R451;    TAC CONTROL
        ACT,,.19,R452;    FCS
        ACT,,.27,R453;    COMM-NAV
        ACT,,.26;         JET ENGINE
        AWAIT(11),A426X4/3;
        ACT/39,RLOGN(XX(56),ATRIB(56),3);
        FREE,A426X4/3;
AS20    ASSIGN,ATRIB(10)=EXPON(XX(15),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,,S451;
R451    AWAIT(12),A326X6/3;
        ACT/39,RLOGN(XX(56),ATRIB(56),3);
        FREE,A326X6/3;
        ACT,,,AS20;
R452    AWAIT(21),A326X7/2;
        ACT/39,RLOGN(XX(56),ATRIB(56),3);
        FREE,A326X7/2;
        ACT,,,AS20;
R453    AWAIT(22),A326X8/2;
        ACT/39,RLOGN(XX(56),ATRIB(56),3);
        FREE,A326X8/2;
        ACT,,,AS20;
S451    AWAIT(4),A423X0/3;
        ACT/40,RLOGN(XX(57),ATRIB(57),3);
        FREE,A423X0/3;
        ACT,,,COL;
;
;
UM46    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.19,RR46;    REMOVE AND REPLACE
```

```
        ACT,,.81;           ON A/C REPAIR
        GOON;
        ACT,,.72,A461;      FUEL
        ACT,,.15,A462;      FCS
        ACT,,.13;           TAC CONTROL
        AWAIT(12),A326X6/3;
        ACT/41,RLOGN(XX(58),ATRIB(58),3);
        FREE,A326X6/3;
AS21    ASSIGN,ATRIB(11)=EXPON(XX(16),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A461    AWAIT(9),A423X3/3;
        ACT/41,RLOGN(XX(58),ATRIB(58),3);
        FREE,A423X3/3;
        ACT,,,AS21;
A462    AWAIT(21),A326X7/3;
        ACT/41,RLOGN(XX(58),ATRIB(58),3);
        FREE,A326X7/3;
        ACT,,,AS21;
RR46    GOON;
        ACT,,.69,R461;      FUEL
        ACT,,.31;           TAC A/C CONTROL
        AWAIT(2),A431R1/2;
        ACT/42,RLOGN(XX(59),ATRIB(59),3);
        FREE,A431R1/2;
AS22    ASSIGN,ATRIB(11)=EXPON(XX(16),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,.50,S461;      FUEL
        ACT,,.50,S462;      STRUCTURAL REPAIR
R461    AWAIT(9),A423X3/3;
        ACT/42,RLOGN(XX(59),ATRIB(59),3);
        FREE,A423X3/3;
        ACT,,,AS22;
S461    AWAIT(9),A423X3/3;
        ACT/43,RLOGN(XX(60),ATRIB(60),3);
        FREE,A423X3/3;
        ACT,,,COL;
S462    AWAIT(2),A431R1/2;
        ACT/43,RLOGN(XX(60),ATRIB(60),3);
        FREE,A431R1/2;
        ACT,,,COL;
;
;
UM47    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.04,RR47;      REMOVE AND REPLACE
        ACT,,.96;           ON A/C REPAIR
        GOON;
        ACT,,.17,A471;      JET ENGINE
        ACT,,.23,A472;      COMM-NAV
        ACT,,.60;           ENVI.SHOP
        AWAIT(5),A423X1/3;
        ACT/44,RLOGN(XX(61),ATRIB(61),3);
        FREE,A423X1/3;
```

```
AS23    ASSIGN,ATRIB(12)=EXPON(XX(17),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A471    AWAIT(11),A426X4/2;
        ACT/44,RLOGN(XX(61),ATRIB(61),3);
        FREE,A426X4/2;
        ACT,,,AS23;
A472    AWAIT(22),A326X8/2;
        ACT/44,RLOGN(XX(61),ATRIB(61),3);
        FREE,A326X8/2;
        ACT,,,AS23;
RR47    GOON;
        ACT,,.50,R471;      COMM-NAV
        ACT,,.25,R472;      FCS
        ACT,,.12,R473;      TAC CONTROL
        ACT,,.13;           JET ENGINE
        AWAIT(11),A426X4/2;
        ACT/45,RLOGN(XX(62),ATRIB(62),3);
        FREE,A426X4/2;
AS24    ASSIGN,ATRIB(12)=EXPON(XX(17),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
R471    AWAIT(22),A326X8/2;
        ACT/45,RLOGN(XX(62),ATRIB(62),3);
        FREE,A326X8/2;
        ACT,,,AS24;
R472    AWAIT(21),A326X7/2;
        ACT/45,RLOGN(XX(62),ATRIB(62),3);
        FREE,A326X7/2;
        ACT,,,AS24;
R473    AWAIT(12),A326X6/2;
        ACT/45,RLOGN(XX(62),ATRIB(62),3);
        FREE,A326X6/2;
        ACT,,,AS24;
;
;
UM49    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.40,RR49;      REMOVE AND REPLACE
        ACT,,.60;           ON A/C REPAIR
        GOON;
        ACT,,.40,A491;      TAC CONTROL
        ACT,,.15,A492;      FCS
        ACT,,.45;           ELECT.SHOP
        AWAIT(4),A423X0/2;
        ACT/46,RLOGN(XX(63),ATRIB(63),3);
        FREE,A423X0/2;
AS25    ASSIGN,ATRIB(13)=EXPON(XX(18),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A491    AWAIT(12),A326X6/2;
        ACT/46,RLOGN(XX(63),ATRIB(63),3);
        FREE,A326X6/2;
        ACT,,,AS25;
A492    AWAIT(21),A326X7/2;
        ACT/46,RLOGN(XX(63),ATRIB(63),3);
```

```
        FREE,A326X7/2;
        ACT,,,AS25;
RR49    AWAIT(12),A326X6/2;
        ACT/47,RLOGN(XX(64),ATRIB(64),3);
        FREE,A326X6/2;
        ACT,,,AS25;
;
;
UM51    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.36,RR51;     REMOVE AND REPLACE
        ACT,,.64;          ON A/C REPAIR
        GOON;
        ACT,,.35,A511;     TAC CONTROL
        ACT,,.30,A512;     FCS
        ACT,,.35;          COMM-NAV
        AWAIT(22),A326X8/3;
        ACT/48,RLOGN(XX(65),ATRIB(65),3);
        FREE,A326X8/3;
AS26    ASSIGN,ATRIB(14)=EXPON(XX(19),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A511    AWAIT(12),A326X6/3;
        ACT/48,RLOGN(XX(65),ATRIB(65),3);
        FREE,A326X6/3;
        ACT,,,AS26;
A512    AWAIT(21),A326X7/3;
        ACT/48,RLOGN(XX(65),ATRIB(65),3);
        FREE,A326X7/3;
        ACT,,,AS26;
RR51    GOON;
        ACT,,.21,R511;     TAC CONTROL
        ACT,,.37,R512;     FCS
        ACT,,.42;          TAC A/C MAINT.
        AWAIT(22),A326X8/2;
        ACT/49,RLOGN(XX(66),ATRIB(66),3);
        FREE,A326X8/2;
AS27    ASSIGN,ATRIB(14)=EXPON(XX(19),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,,S511;    AUTO TEST STATION
R511    AWAIT(12),A326X6/3;
        ACT/49,RLOGN(XX(66),ATRIB(66),3);
        FREE,A326X6/3;
        ACT,,,AS27;
R512    AWAIT(21),A326X7/2;
        ACT/49,RLOGN(XX(66),ATRIB(66),3);
        FREE,A326X7/2;
        ACT,,,AS27;
S511    AWAIT(20),A326X4/2;
        ACT/50,RLOGN(XX(67),ATRIB(67),3);
        FREE,A326X4/2;
        ACT,,,COL;
;
;
```

```
UM55    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.32,RR55;     REMOVE AND REPLACE
        ACT,,.68;          ON A/C REPAIR
        GOON;
        ACT,,.60,A551;     TAC CONTROL
        ACT,,.15,A552;     FCS
        ACT,,.25;          TAC A/C MAINT.
        AWAIT(2),A431R1/1;
        ACT/51,RLOGN(XX(68),ATRIB(68),3);
        FREE,A431R1/1;
AS28    ASSIGN,ATRIB(15)=EXPON(XX(20),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A551    AWAIT(12),A326X6/2;
        ACT/51,RLOGN(XX(68),ATRIB(68),3);
        FREE,A326X6/2;
        ACT,,,AS28;
A552    AWAIT(21),A326X7/2;
        ACT/51,RLOGN(XX(68),ATRIB(68),3);
        FREE,A326X7/2;
        ACT,,,AS28;
RR55    GOON;
        ACT,,.32,R551;     TAC A/C MAINT.
        ACT,,.18,R552;     COMM-NAV
        ACT,,.50;          FCS
        AWAIT(21),A326X7/2;
        ACT/52,RLOGN(XX(69),ATRIB(69),3);
        FREE,A326X7/2;
AS29    ASSIGN,ATRIB(15)=EXPON(XX(20),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
R551    AWAIT(2),A431R1/1;
        ACT/52,RLOGN(XX(69),ATRIB(69),3);
        FREE,A431R1/1;
        ACT,,,AS29;
R552    AWAIT(22),A326X8/2;
        ACT/52,RLOGN(XX(69),ATRIB(69),3);
        FREE,A326X8/2;
        ACT,,,AS29;
;
;
UM62    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.34,RR62;     REMOVE AND REPLACE
        ACT,,.66;          ON A/C REPAIR
        GOON;
        ACT,,.23,A621;     TAC CONTROL
        ACT,,.17,A622;     FCS
        ACT,,.60;          COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/53,RLOGN(XX(70),ATRIB(70),3);
        FREE,A326X8/2;
AS30    ASSIGN,ATRIB(16)=EXPON(XX(21),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
```

```
A621    AWAIT(12),A326X6/2;
        ACT/53,RLOGN(XX(70),ATRIB(70),3);
        FREE,A326X6/2;
        ACT,,,AS30;
A622    AWAIT(21),A326X7/2;
        ACT/53,RLOGN(XX(70),ATRIB(70),3);
        FREE,A326X7/2;
        ACT,,,AS30;
RR62    GOON;
        ACT,,.13,R621;    TAC CONTROL
        ACT,,.28,R622;    FCS
        ACT,,.59;         COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/54,RLOGN(XX(71),ATRIB(71),3);
        FREE,A326X8/2;
AS31    ASSIGN,ATRIB(16)=EXPON(XX(21),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,,S621;    AUTO TEST STATION
R621    AWAIT(12),A326X6/2;
        ACT/54,RLOGN(XX(71),ATRIB(71),3);
        FREE,A326X6/2;
        ACT,,,AS31;
R622    AWAIT(21),A326X7/2;
        ACT/54,RLOGN(XX(71),ATRIB(71),3);
        FREE,A326X7/2;
        ACT,,,AS31;
S621    AWAIT(20),A326X4/2;
        ACT/55,RLOGN(XX(72),ATRIB(72),3);
        FREE,A326X4/2;
        ACT,,,COL;
;
;
UM63    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.40,RR63;    REMOVE AND REPLACE
        ACT,,.60;         ON A/C REPAIR
        GOON;
        ACT,,.28,A631;    TAC CONTROL
        ACT,,.30,A632;    FCS
        ACT,,.42;         COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/56,RLOGN(XX(73),ATRIB(73),3);
        FREE,A326X8/2;
AS32    ASSIGN,ATRIB(17)=EXPON(XX(22),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A631    AWAIT(12),A326X6/2;
        ACT/56,RLOGN(XX(73,ATRIB(73),3);
        FREE,A326X6/2;
        ACT,,,AS32;
A632    AWAIT(21),A326X7/2;
        ACT/56,RLOGN(XX(73),ATRIB(73),3);
        FREE,A326X7/2;
        ACT,,,AS32;
```

```
RR63    GOON;
        ACT,,.19,R631;    TAC CONTROL
        ACT,,.36,R632;    FCS
        ACT,,.45;         COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/57,RLOGN(XX(74),ATRIB(74),3);
        FREE,A326X8/2;
AS33    ASSIGN,ATRIB(17)=EXPON(XX(22),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,,S631;    AUTO TEST STATION
R631    AWAIT(12),A326X6/2;
        ACT/57,RLOGN(XX(74),ATRIB(74),3);
        FREE,A326X6/2;
        ACT,,,AS33;
R632    AWAIT(21),A326X7/2;
        ACT/57,RLOGN(XX(74),ATRIB(74),3);
        FREE,A326X7/2;
        ACT,,,AS33;
S631    AWAIT(20),A326X4/2;
        ACT/58,RLOGN(XX(75),ATRIB(75),3);
        FREE,A326X4/2;
        ACT,,,COL;
;
;
UM64    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.18,RR64;    REMOVE AND REPLACE
        ACT,,.81;         ON A/C REPAIR
        GOON;
        ACT,,.39,A641;    TAC CONTROL
        ACT,,.11,A642;    FCS
        ACT,,.50;         COMM-NAV
        AWAIT(23),A326X8/2;
        ACT/59,RLOGN(XX(76),ATRIB(76),3);
        FREE,A326X8/2;
AS34    ASSIGN,ATRIB(18)=EXPON(XX(23),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A641    AWAIT(12),A326X6/2;
        ACT/59,RLOGN(XX(76),ATRIB(76),3);
        FREE,A326X6/2;
        ACT,,,AS34;
A642    AWAIT(21),A326X7/2;
        ACT/59,RLOGN(XX(76),ATRIB(76),3);
        FREE,A326X7/2;
        ACT,,,AS34;
RR64    GOON;
        ACT,,.30,R641;    FCS
        ACT,,.70;         COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/60,RLOGN(XX(77),ATRIB(77),3);
        FREE,A326X8/2;
AS35    ASSIGN,ATRIB(18)=EXPON(XX(23),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
```

```
R641    AWAIT(21),A326X7/2;
        ACT/60,RLOGN(XX(77),ATRIB(77),3);
        FREE,A326X7/2;
        ACT,,,AS35;
;
;
UM65    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.26,RR65;     REMOVE AND REPLACE
        ACT,,.74;          ON A/C REPAIR
        GOON;
        ACT,,.2[illegible],A651;     TAC CONTROL
        ACT,,.20,A652;     FCS
        ACT,,.53;          COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/61,RLOGN(XX(78),ATRIB(78),3);
        FREE,A326X8/2;
AS36    ASSIGN,ATRIB(19)=EXPON(XX(24),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A651    AWAIT(12),A326X6/2;
        ACT/61,RLOGN(XX(78),ATRIB(78),3);
        FREE,A326X6/2;
        ACT,,,AS36;
A652    AWAIT(21),A326X7/2;
        ACT/61,RLOGN(XX(78),ATRIB(78),3);
        FREE,A326X7/2;
        ACT,,,AS36;
RR65    GOON;
        ACT,,.28,R651;     TAC CONTROL
        ACT,,.23,R652;     FCS
        ACT,,.49;          COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/62,RLOGN(XX(79),ATRIB(79),3);
        FREE,A326X8/2;
AS37    ASSIGN,ATRIB(19)=EXPON(XX(24),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
R651    AWAIT(12),A326X6/2;
        ACT/62,RLOGN(XX(79),ATRIB(79),3);
        FREE,A326X6/2;
        ACT,,,AS37;
R652    AWAIT(21),A326X7/2;
        ACT/62,RLOGN(XX(79),ATRIB(79),3);
        FREE,A326X7/2;
        ACT,,,AS37;
;
;
UM71    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.34,RR71;     REMOVE AND REPLACE
        ACT,,.66;          ON A/C REPAIR
        GOON;
        ACT,,.17,A711;     TAC CONTROL
        ACT,,.20,A712;     FCS
```

```
         ACT,,.63;              COMM-NAV
         AWAIT(22),A326X8/2;
         ACT/63,RLOGN(XX(80),ATRIB(80),3);
         FREE,A326X8/2;
AS38     ASSIGN,ATRIB(20)=EXPON(XX(25),1),XX(5)=XX(5)+1;
         ACT,,,GN1;
A711     AWAIT(12),A326X6/2;
         ACT/63,RLOGN(XX(80),ATRIB(80),3);
         FREE,A326X6/2;
         ACT,,,AS38;
A712     AWAIT(21),A326X7/2;
         ACT/63,RLOGN(XX(80),ATRIB(80),3);
         FREE,A326X7/2;
         ACT,,,AS38;
RR71     GOON;
         ACT,,.16,R711;    TAC CONTROL
         ACT,,.41,R712;    FCS
         ACT,,.43;         COMM-NAV
         AWAIT(22),A326X8/2;
         ACT/64,RLOGN(XX(81),ATRIB(81),3);
         FREE,A326X8/2;
AS39     ASSIGN,ATRIB(20)=EXPON(XX(25),1),XX(5)=XX(5)+1;
         ACT,,,GN1;
R711     AWAIT(12),A326X6/2;
         ACT/64,RLOGN(XX(81),ATRIB(81),3);
         FREE,A326X6/2;
         ACT,,,AS39;
R712     AWAIT(21),A326X7/2;
         ACT/64,RLOGN(XX(81),ATRIB(81),3);
         FREE,A326X7/2;
         ACT,,,AS39;
;
;
UM74     ASSIGN,XX(5)=XX(5)-1;
         GOON;
         ACT,,.31,RR74;    REMOVE AND ERPLACE
         ACT,,.69;         ON A/C REPAIR
         GOON;
         ACT,,.34,A741;    TAC CONTROL
         ACT,,.15,A742;    FCS
         ACT,,.29,A743;    COMM-NAV
         ACT,,.22;         PHOTO-SENSOR
         AWAIT(15),A404X1/2;
         ACT/65,RLOGN(XX(82),ATRIB(82),3);
         FREE,A404X1/2;
AS40     ASSIGN,ATRIB(21)=EXPON(XX(26),1),XX(5)=XX(5)+1;
         ACT,,,GN1;
A741     AWAIT(12),A326X6/2;
         ACT/65,RLOGN(XX(82),ATRIB(82),3);
         FREE,A326X6/2;
         ACT,,,AS40;
A742     AWAIT(21),A326X7/3;
         ACT/65,RLOGN(XX(82),ATRIB(82),3);
```

```
        FREE,A326X7/3;
        ACT,,,AS40;
A743    AWAIT(22),A326X8/2;
        ACT/65,RLOGN(XX(82),ATRIB(82),3);
        FREE,A326X8/2;
        ACT,,,AS40;
RR74    GOON;
        ACT,,.17,R741;    TAC CONTROL
        ACT,,.35,R742;    FCS
        ACT,,.34,R742;    COMM-NAV
        ACT,,.14;         PHOTO-SENSOR
        AWAIT(15),A404X1/2;
        ACT/66,RLOGN(XX(83),ATRIB(83),3);
        FREE,A404X1/2;
AS41    ASSIGN,ATRIB(21)=EXPON(XX(26),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,,S741;   PHOTO -SENSOR
R741    AWAIT(12),A326X6/2;
        ACT/66,RLOGN(XX(83),ATRIB(83),3);
        FREE,A326X6/2;
        ACT,,,AS41;
R742    AWAIT(21),A326X7/2;
        ACT/66,RLOGN(XX(83),ATRIB(83),3);
        FREE,A326X7/2;
        ACT,,,AS41;
R743    AWAIT(22),A326X8/2;
        ACT/66,RLOGN(XX(83),ATRIB(83),3);
        FREE,A326X8/2;
        ACT,,,AS41;
S741    AWAIT(15),A404X1/2;
        ACT/67,RLOGN(XX(84),ATRIB(84),3);
        FREE,A404X1/2;
        ACT,,,COL;
;
;
UM75    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.22,RR75;    REMOVE AND REPLACE
        ACT,,.78;         ON A/C REPAIR
        AWAIT(19),A462X0/3;   MUNITION SHOP
        ACT/68,RLOGN(XX(85),ATRIB(85),3);
        FREE,A462X0/3;
AS42    ASSIGN,ATRIB(22)=EXPON(XX(27),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
RR75    AWAIT(19),A462X0/3;   MUNITION SHOP
        ACT/69,RLOGN(XX(86),ATRIB(86),3);
        FREE,A462X0/3;
        ACT,,,AS42;
        ACT,,.55,S751;    MUNITION SHOP
        ACT,,.35,S752;    AUTO TEST STATION
        ACT,,.10,S753;    METAL PROCESSING
S751    AWAIT(19),A462X0/2;
        ACT/70,RLOGN(XX(87),ATRIB(87),3);
```

```
        FREE,A462X0/2;
        ACT,,,COL;
S752    AWAIT(20),A326X4/2;
        ACT/70,RLOGN(XX(87),ATRIB(87),3);
        FREE,A326X4/2;
        ACT,,,COL;
S753    AWAIT(3),A427X4/2;
        ACT/70,RLOGN(XX(87),ATRIB(87),3);
        FREE,A427X4/2;
        ACT,,,COL;
;
;
UM76    ASSIGN,XX(5)=XX(5)-1;
        GOON;
        ACT,,.30,RR76;     REMOVE AND REPLACE
        ACT,,.70;          ON A/C REPAIR
        GOON;
        ACT,,.30,A761;     TAC CONTROL
        ACT,,.17,A762;     FCS
        ACT,,.53;          COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/71,RLOGN(XX(88),ATRIB(88),3);
        FREE,A326X8/2;
AS44    ASSIGN,ATRIB(23)=EXPON(XX(28),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
A761    AWAIT(12),A326X6/2;
        ACT/71,RLOGN(XX(88),ATRIB(88),3);
        FREE,A326X6/2;
        ACT,,,AS44;
A762    AWAIT(21),A326X7/2;
        ACT/71,RLOGN(XX(88),ATRIB(88),3);
        FREE A326X7/2;
        ACT,,,AS44;
RR76    GOON;
        ACT,,.19,R761;     TAC CONTROL
        ACT,,.18,R762;     FCS
        ACT,,.63;          COMM-NAV
        AWAIT(22),A326X8/2;
        ACT/72,RLOGN(XX(89),ATRIB(89),3);
        FREE,A326X8/2;
AS45    ASSIGN,ATRIB(23)=EXPON(XX(28),1),XX(5)=XX(5)+1;
        ACT,,,GN1;
        ACT,,,S761;    AUTO TEST STATION
R761    AWAIT(12),A326X6/2;
        ACT/72,RLOGN(XX(89),ATRIB(89),3);
        FREE,A326X6/2;
        ACT,,,AS45;
R762    AWAIT(21),A326X7/2;
        ACT/72,RLOGN(XX(89),ATRIB(89),3);
        FREE,A326X7/2;
        ACT,,,AS45;
S761    AWAIT(20),A326X4/2;
        ACT/73,RLOGN(XX(90),ATRIB(90),3);
```

```
        FREE,A326X4/2;
COL     COLCT,INT(95),RPR CYCLE TIME;
        TERM;
;
;       MODEL SEGMENT VI   ** PHASE MAINTENANCE **
;
PH1     ASSIGN,XX(5)=XX(5)-1;
        ACT/74,UNFRM(24,36,4);
        ASSIGN.ATRIB(24)=600,ATRIB(92)=1,XX(5)=XX(5)+1;
        ACT,,,COL1;
PH2     ASSIGN,XX(5)=XX(5)-1;
        ACT/75,UNFRM(24,36,4);
        ASSIGN,ATRIB(25)=600,ATRIB(92)=1,XX(5)=XX(5)+1;
        ACT,,,COL1;
PH3     ASSIGN,XX(5)=XX(5)-1;
        ACT/76,UNFRM(24,36,4);
        ASSIGN,ATRIB(26)=600,ATRIB(92)=1,XX(5)=XX(5)+1;
        ACT,,,COL1;
PH4     ASSIGN,XX(5)=XX(5)-1;
        ACT/77,UNFRM(24,36,4);
        ASSIGN,ATRIB(27)=600,ATRIB(92)=1,XX(5)=XX(5)+1;
        ACT,,,COL1;
;
        ENDNETWORK;
        INIT,0,6288;
        MONTR,CLEAR,240;
        FIN;
```

S L A M I I S U M M A R Y R E P O R T

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	NO. OF OBS
TURN TIME	0.485E+01	0.406E+01	0.114E+01	0.524E+02	4778
MAINT TIME	0.422E+01	0.799E+01	0.000E+00	0.631E+02	5039
SORTIES	0.200E+02	0.000E+00	0.200E+02	0.200E+02	252
RPR CYCLE TIME	0.127E+02	0.112E+02	0.160E+01	0.759E+02	1012

STATISTICS FOR TIME-PERSISTENT VARIABLES

	MEAN VALUE	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	CURRENT VALUE
MSN CAP ACFT	14.479	3.051	2.00	18.00	16.00

FILE STATISTICS

FILE NUMBER	ASSOC NODE LABEL/TYPE	AVERAGE LENGTH	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	PRE AWAIT	0.262	12	0	0.157
2	A111 AWAIT	0.004	1	0	0.054
3	S232 AWAIT	0.012	2	0	2.906
4	S124 AWAIT	0.010	1	0	0.232
5	R411 AWAIT	0.002	2	0	0.232
23	RTRN AWAIT	10.507	18	0	12.424
24	AWAIT	0.053	18	0	0.063
25	CALENDAR	12.271	28	22	0.590

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
1 PREFLIGHT CH	0.9954	5	0	5039
2 FLY SORTIE	1.6595	18	0	5040
4 PERFORM POST	0.2516	5	0	5040
5	0.0000	1	0	4026
6	0.0673	1	0	234
13	0.1001	5	0	488
14	0.0299	2	0	51
15	0.0730	2	0	51
16	0.0602	2	0	114

17	0.0085	1	0	18
18	0.0092	2	0	18
68	0.0818	2	0	153
69	0.0167	2	0	39
70	0.0446	2	0	39
71	0.0551	3	0	104
72	0.0202	2	0	33
73	0.0454	2	0	33
74	0.3565	6	0	71
75	0.3642	9	0	72
76	0.3281	5	2	64
77	0.2734	6	0	54

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	MAXIMUM UTIL	CURRENT UTIL
1	A431F1	20	4.99	20	0
2	A431R1	7	0.36	7	0
3	A427X4	2	0.05	2	0
4	A423X0	9	1.55	9	0
5	A423X1	3	0.05	3	0
6	A423X4	6	0.13	6	0
7	A423X3	10	0.68	10	0
8	A426X4	10	0.86	10	0
9	A326X6	26	13.67	26	21
10	A427X5	2	0.11	2	0
11	A427X3	2	0.00	2	0
12	A404X1	4	0.27	4	0
13	A423X2	3	0.18	3	0
14	A426T4	2	0.20	2	0
15	A462X0	6	0.34	6	0
16	A326X4	6	0.47	6	0
17	A326X7	8	0.75	8	0
18	A326X8	12	1.22	12	0

GATE STATISTICS

GATE NUMBER	GATE LABEL	CURRENT STATUS	PCT. OF TIME OPEN
1	DAY	OPEN	0.1942
2	STORM	OPEN	0.9327

TIME-PERSISTENT HISTOGRAM NUMBER 1

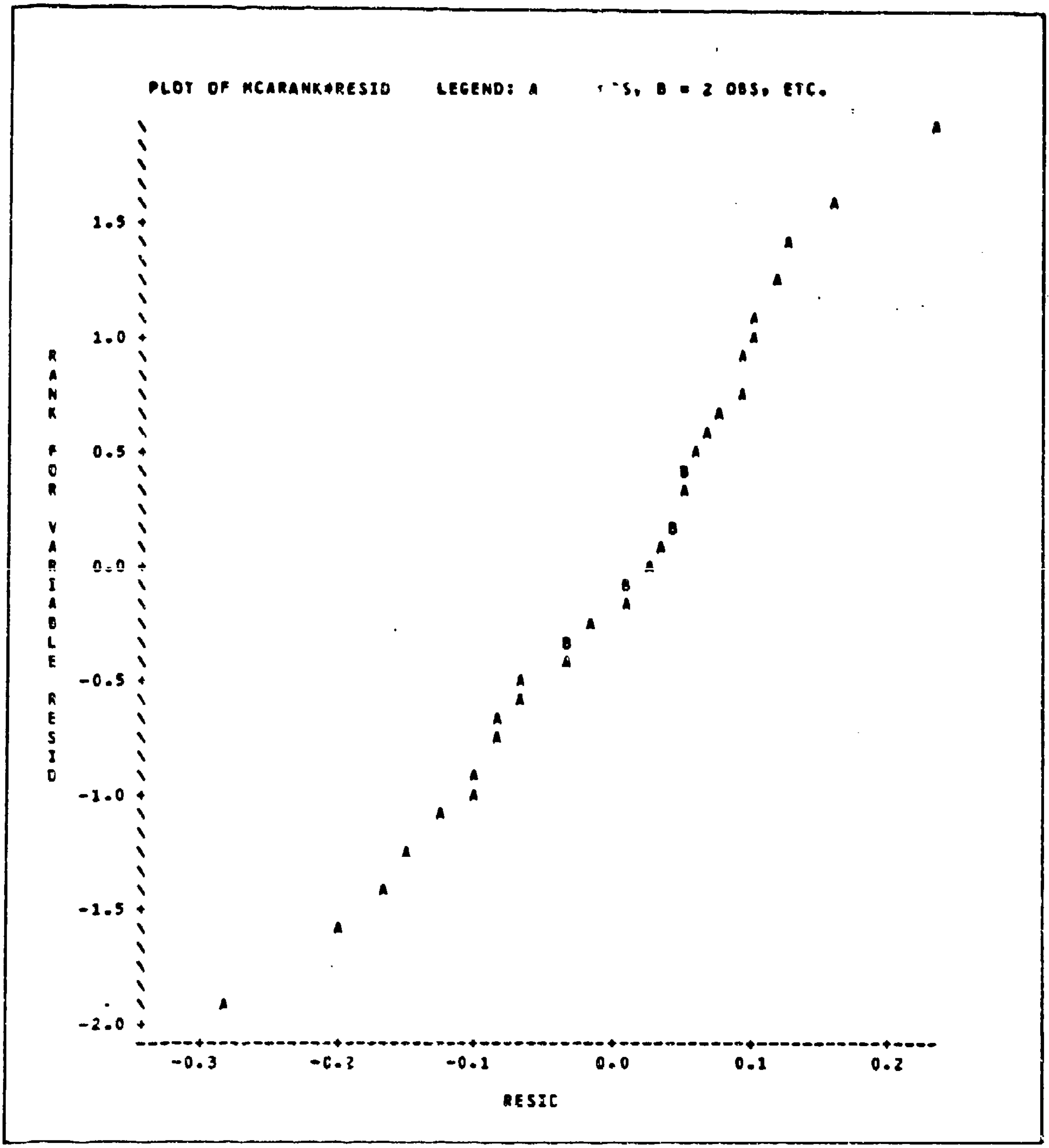
```
                                MSN CAP ACFT
 CELL RELA   UPPER
 TIME FREQ  CELL LIM  0        20        40        60        80       100
                      +    +    +    +    +    +    +    +    +    +    +
    0. 0.00 0.000E+00 +                                                 +
    0. 0.00 0.100E+01 +                                                 +
    1. 0.00 0.200E+01 +                                                 +
    5. 0.00 0.300E+01 +                                                 +
    9. 0.00 0.400E+01 +                                                 +
   19. 0.00 0.500E+01 +                                                 +
   46. 0.01 0.600E+01 +C                                                +
   89. 0.01 0.700E+01 +*                                                +
  138. 0.02 0.800E+01 +* C                                              +
  201. 0.03 0.900E+01 +** C                                             +
  301. 0.05 0.100E+02 +**    C                                          +
  306. 0.05 0.110E+02 +***     C                                        +
  343. 0.06 0.120E+02 +***        C                                     +
  435. 0.07 0.130E+02 +****           C                                 +
  504. 0.08 0.140E+02 +****               C                             +
  788. 0.13 0.150E+02 +*******                 C                       +
  941. 0.16 0.160E+02 +********                        C               +
 **** 0.18 0.170E+02 +*********                                C      +
  850. 0.14 0.180E+02 +*******                                          C
    0. 0.00    INF    +                                                 C
 ---                  +    +    +    +    +    +    +    +    +    +    +
 ****                 0        20        40        60        80       100
```

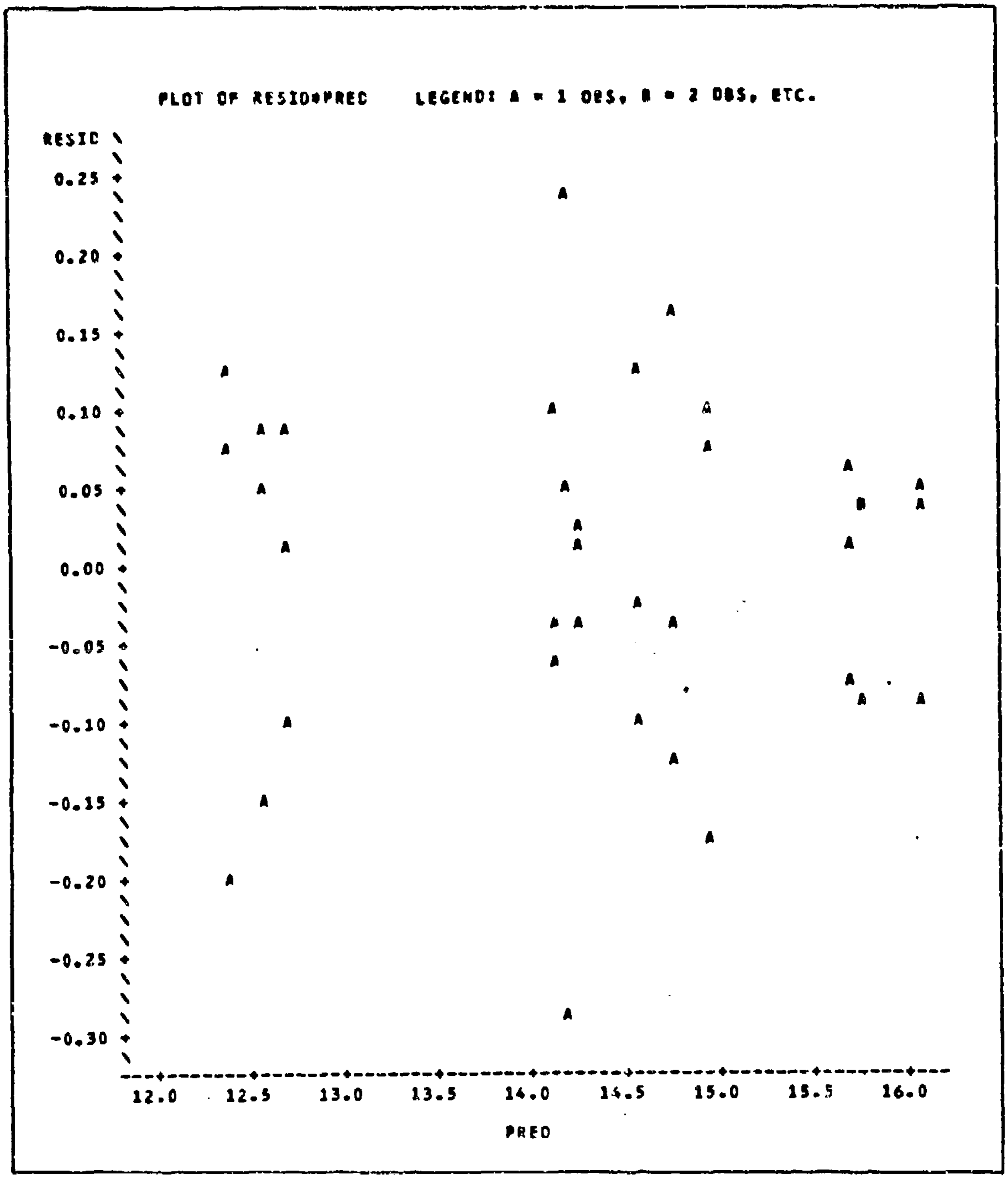
APPENDIX C
SAS INPUT DATA

INPUT A B C MCA SORTIES
CARDS;

-1	-1	-1	12.49	1279
-1	-1	-1	12.17	1253
-1	-1	-1	12.44	1288
-1	-1	0	12.62	1366
-1	-1	0	12.66	1352
-1	-1	0	12.42	1351
-1	-1	1	12.68	1403
-1	-1	1	12.57	1383
-1	-1	1	12.76	1395
-1	1	-1	13.87	1381
-1	1	-1	14.39	1404
-1	1	-1	14.21	1395
-1	1	0	14.30	1499
-1	1	0	14.24	1468
-1	1	0	14.28	1491
-1	1	1	14.20	1538
-1	1	1	14.06	1540
-1	1	1	14.03	1541
1	-1	-1	15.02	1413
1	-1	-1	14.75	1414
1	-1	-1	14.99	1427
1	-1	0	14.91	1556
1	-1	0	14.63	1541
1	-1	0	14.72	1543
1	-1	1	14.40	1595
1	-1	1	14.48	1576
1	-1	1	14.56	1592
1	1	-1	16.09	1452
1	1	-1	15.97	1432
1	1	-1	16.11	1458
1	1	0	15.65	1599
1	1	0	15.78	1617
1	1	0	15.78	1600
1	1	1	15.68	1695
1	1	1	15.60	1673
1	1	1	15.73	1685

```
PROC GLM;
   CLASSES  A  B  C ;
   MODEL  MCA = A  B  C  A*B  A*C  B*C  A*B*C ;
OUTPUT PREDICTED = PRED RESIDUAL = RESID ;
PROC PLOT ;
   PLOT  RESID*PRED ;
PROC RANK NORMAL = VW ;
   VAR RESID ;
   RANKS MCARANK ;
PROC PLOT ;
   PLOT MCARANK*RESID ;
PROC PRINT ;
```


PLOT OF HCARANK*RESID LEGEND: A
S, B = 2 OBS, ETC.
RANK FOR VARIABLE RESID
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-0.3
-0.2
-0.1
0.0
0.1
0.2
RESID


PLOT OF RESID*PRED LEGEND: A = 1 OBS, B = 2 OBS, ETC.
RESID
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
PRED

Bibliography

1. Codispoti, Joseph M. & McClain, Michael L. REMO II: USAF Commitment to Turkish Air Force Logistics Self-Sufficiency, MS Thesis, LSM-84S-10 School of System and Logistics, Air Force Institute of Technology, Wright-Patterson AFB, OH, September 1984

2. Peace Onyx Program Managment Review II, General Dynamics, Ft. Worth, Tx, April 1985

3. Calabro, S.R. Reliability Principles and Practices. New York: McGraw-Hill Book Company, 1962

4. Gene, Bartlow S. "Institutionalizing Air force Reliability and Maintainability (R&M)," Air Force Journal of Logistics, 9:9-13 (Summer 1985)

5. James, Kniss R. "Developing Reliable Systems...Fact versus Fiction," National Defense, 68:24-27 (March 1984)

6. Gordon, Hodgson M. "Reliability and Maintainability in the Air Force," Air Force Journal of Logistics, 8:10-13

7. Seyithanoglu, Lt.Col Mete. Technical Represention of TUAF. Personal interview, Hill AFB, Utah, 2 July through 8 November 1986

8. Yilmaz, Aydin A. Comparison of Centralized-Manual, Centralized-Computerized, and Decentralized-Computerized Order and Managment Information Models for the Turkish Air Force Logistic System, MS Thesis, LSM-86S-14, School of System and Logistics, Air Force Institute of Technology, Wright-Patterson AFB, OH, September 1986

9. Leachman, William D. and Vitito, Thomas E. "Maintenance Managemant," in Managing the Air Force. Montgomery, AL: Air War College, 1983

10. Pritsker, A. Alan B. Introduction to Simulation and SLAM II. New York: John Wiley & Sons, Inc., 1984

11. Banks, Jerry and Jonh, Carson S. Discrete-Event System Simulation. New Jersey: Prentice Hall, Inc., 1984

12. Department of teh Air Force. Logistics Composite Modeling (LCOM) System User Manual. AFM 171-605. Washington: HQ USAF, 1 February 1985

13. ---, Simulation Maintenance Manning For New Weapon Systems: Maintenance Data Analysis Programs. ASD, Wright-Patterson AFB, Dayto OH, May 1986

14. Montgomery, Douglas C. Design and Analysis of Experiments (Second Edition). New York: John Wiley & Sons, Inc., 1984

15. ---, SAS User's Guide: Statistics, SAS Institute Inc., 1985

16. Lee, Schrubeu W. and Morgolin, Barry H. "Pseudorandom Number Assignment in Statistically Designed Simulation and Distribution Sampling Experiments," Journal of the American Statistical Association, Vol 73, pp:504-520 (September 1978)

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Thesis Advisor: Joseph R. Litko, Ph.D., Major, USAF
Assistant Professor, Department of Operational Sciences

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The Turkish Air Force (TUAF) has decided to change its current centralized aircraft maintenance system to the combat oriented maintenance system for the F-16 implementation. An aircraft maintenance system is a highly complex system of resources and activities that interact to maintain a pool of mission capable aircraft. Because of its contribution to operational readiness and sustainability, managing manpower resources becomes even more critical as the new program is implemented and a new weapon system becomes operational.

Enhanced supportability depends upon efficient and effective resource allocation. In addition to the many other topics concerning resource allocation and investment trade off, improved reliability and maintainability (R&M) of modern weapon systems have become the focus of the top level decision makers. To assist in the R&M, a simulation model of the aircraft maintenance system for a generic fighter squadron was developed using Simulation Language for Alternative Modeling (SLAM). This research specifically addressed the impact of reliability and maintainability on maintenance manpower requirements and mission effectiveness. An additional question examined is the impact of the consolidation of maintenance specialities on maintenance manpower requirements. A full factorial analysis of variance was used to address the impact of R&M on mission effectiveness. A non-statistical analysis was performed to address the impact of R&M on maintenance manpower requirements.

Due to manner in which this model has been constructed, it is a flexible model that can be easily adapted to a different aircraft. ([illegible]).